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A QUALITATIVE ANALYSIS OF TICKLING: ITS RELATION TO CUTANEOUS AND ORGANIC SENSATION[1]

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[1] From the Psychological Laboratory of Cornell University.

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The following study was undertaken in the interests of certain problems in the analysis and classification of organic sensation. It was our belief that the thorough examination of some complex lying, so to say, on the border line between the cutaneous and the organic might open up a pathway to the more detailed investigation of the latter. For such preliminary exploration the use of the phenomenon of ticklishness or tickling seemed obviously appropriate.

While the primary object of experimentation in the work which follows was the analysis of the immediate sensory contents of tickle, the possibility that the uniqueness of the tickle-consciousness may lie merely in the bodily reaction which it excites was not lost sight of. The questions which we set ourselves to answer were as follows. Are the ticklish sensations aroused by a light touch to be classed as cutaneous or organic?[1] Do they represent pressure,[2] a new pain quality,[3] a complex of

[1] By organic is here meant a sensation mediated by non-cutaneous nerve endings, hence presumably unique in quality.

[2] *Cf.* A. Goldscheider, Die specifische Energie der Gefühlsnerven der Haut, 1884; F. Kiesow, *Zeitschrift für Psych. und Phys. der Sinnesorgane*, XXXIII, 429-430; and O. Külpe, Outlines of Psychology, 1895, 148.

[3] S. Alrutz, Undersökingar öfner smärtsinnet, *Upsala Univ. Arskrift*, 1901.

tactual and muscular impressions,[1] circulatory sensations reflexly aroused,[2] or pressure and pain in combination? Lastly, if it is non-organic in origin, upon what conditions or peculiarities of content does the strikingly subjective character of the tickle-consciousness depend?

In the solution of this problem our interest was not confined to the determination of the independence or identity of the points of maximal sensitivity for tickle and those for any other sensation, pain or pressure. The emphasis was rather upon the introspective estimation of the qualitative likeness or unlikeness of tickle and certain simple variations and complications of pain, pressure, and the like. Full experiential knowledge of the cutaneous qualities, under varying intensive, spatial, and temporal conditions, was thus acquired. The methodological value of this material for the further study of organic sensations is readily apparent. For the task of isolating, disintegrating, and classifying such organic complexes as hunger, thirst, fatigue, and the bodily accompaniments of the emotions, certain factors in the introspective outfit of the observer are (as a brief experience proves) indispensable. The first is the possession of a tolerably stable set of standard elements, drawn from the sense departments that are most germane (tactual and kinæsthetic). The second is a rough descriptive catalogue or working knowledge of the apparent modifications of quality[3] which any simple element may undergo, *i. e.*, of the simplest laws of fusion and complication.

The close dependence of progress in organic analysis upon such preliminary knowledge may be illustrated as follows. One of the first questions which arises in the study of organic sensation hinges upon the significance of the distinction between "dull" and "sharp" or "bright." Does the division of organic sensation into two classes, which seems roughly feasible, represent an ultimate sensory distinction? Are there two qualities, the one invariably correlated with plain muscle activity, the other possibly with circulatory changes in the internal tissues? Or are dullness and sharpness modifications

[1] W. Wundt, Human and Animal Psychology; C. S. Sherrington, in Schäfer's Textbook of Physiology, II, 976.

[2] Suggested by M. von Frey: *Berichte d. math.-phys. Classe d. kön. säch. Gesellschaft*, 1894, 192.

[3] The observations recorded in this article, along with a series of introspections on kinæsthetic sensations, tingling, heat and cold pain, neuralgic pain, etc., kept by the writer for a number of months, have resulted in distrust of many verbal distinctions commonly accepted as qualitative and ultimate. The apparent qualitative diversity, reducible to the metamorphoses of a single quality under varied conditions of massing and duplication, is hardly less considerable than the diversity attainable through the varied spatial disposition and intensive modification of a single visual quality, as gray.

of a single original quality, brought about by alterations in spatial extent, intensity, or the effectiveness of attention? Again, the question arises of the affinity on the one hand to pain, on the other to contact, of certain bright or sharp sensations felt internally in the "thrill" of pleasure or excitement, in the tingling of a limb which has been asleep, and in other contexts. In both cases, experimental variation of the conditions in the sphere of cutaneous sensation, and an introspective knowledge of cutaneous pain at low intensities, offer a short cut in the direction of the probabilities which the experimenter cannot afford to neglect. Thirdly, in the study of organic and semi-organic complexes the possibility of the deceptiveness of certain judgments, such as that of localization in the third dimension (*i. e.*, lack of projection beyond the surface of the body), arises. Familiarity with the underlying structural pattern and with the reliability of such judgments in the sphere of cutaneous sensation is the necessary preliminary for any adequate examination of this question.

Section A. Pressure and Pressure Spots

This section of the work was designed as a preliminary to the study of tickling, and was devoted primarily to the determination of von Frey pressure spots and the development of a definite notion of the characteristic response of a single pressure organ to punctiform stimulation. It was our original intention to identify a few responsive pressure spots, to test them for tickle with a series of graduated intensities, to map a given area for points of maximal sensitivity to tickle and pressure respectively, to compare the results, and so to weigh the probabilities in favor of identifying tickle with the modality of pressure. For the carrying out of the first steps in this programme the method of von Frey and Kiesow, of mapping with minimal stimuli, was obviously inappropriate, since the liminal sensations thus utilized are difficult of analysis to the untrained observer, and may well indicate the locality of tickle rather than of pressure organs. We therefore decided to select, for initial exploration, a stimulus intensity capable of evoking the classical 'granular' pressure quality in its greatest perfection and isolation. This method also is open to objection, in the burden which it lays upon introspection; but apart from its immediate value, it promised precisely the training in the discrimination and description of slight tactual differences which was essential to our general purpose.

At the outset of this procedure, however, technical difficulties and introspective complexities began to make their appearance. Since the latter seemed frequently at odds with accepted qualitative distinctions, we felt obliged to postpone the later steps of our investigation while a series of experiments under vary-

ing hypotheses as to the number and affinities of cutaneous qualities was undertaken. When preliminary experimentation with tickle made further apparent the need of a minuter analysis than was anywhere accessible of the sensations resulting from mechanical stimulation of the skin, this line of the investigation was extended beyond our original intention. The modification which our conception of the elementary tactual sensation underwent, in consequence, will be described later.

The majority of the experiments cited in this article were carried out in the Cornell Laboratory in the year 1906-7. Observers were Professor I. M. Bentley, Mr. L. R. Geissler, assistant in psychology, and two advanced students in the department of psychology, Miss M. C. West and Mr. R. Sailor. Professor T. A. Hunter and a junior student, Miss Rosemon, also contributed a number of results. The writer herself occasionally took the part of observer, and a few of the final results are based solely on her introspections, no other observers being accessible at the time.

Preliminary Experimentation

I. Search for the Adequate Stimulus of Goldscheider's Granular Pressure Sensation. In view of the rare occurence of isolated pressure sensations, and the lack of training of most of the observers in pressure problems, recourse was had to Goldscheider's classical description of the pressure quality.[1] Trial was then made in the vicinity of the larger hair-bulbs on the arm or the back of the hand for a stimulus implement which should give rise to the most perfect fac-simile of the sensation thus described.

To our surprise and disappointment, stimulus hairs of medium diameter (such as were used by von Frey and Kiesow) were effective rather in calling out a bright, sharp, superficial sensation, at its higher intensities tending to merge into pain, than in reproducing the compacted deeper-lying sensation, sometimes sharp, sometimes dull, which gradually became the observer's ideal of an isolated pressure. Hairs of small calibre gave only an elusive tickle, bright contact, or a fine stinging pain, immediate or belated. Bristles, glass hairs, and points of carbon, wood, and cork, of various lengths, diameters, and degrees of sharpness were also tested. The blunter gave everywhere practically the same undifferentiated, dull, diffuse sensations, tending to pass imperceptibly into a subcutaneous ache. The sharper and finer, if sufficiently stout, gave now and then a well-defined pressure, too often, however, marred by an accompanying point of pain which, in its weaker intensities, blended subtly with the pressure proper, to the confusion of the

[1] Die specifische Energie der Gefühlsnerven der Haut, Gesammelte Abhandlungen, i, 1898, 77-8.

observer.[1] Wooden points of a certain sharpness and glass hairs with a welded end gave most uniformly results which accorded with the definition.[2] It was desirable, however, for our further purposes to select an implement the intensity of which could be easily graduated. Choice was finally made of a horse-hair of about 0.2 mm. diameter, fitted into an æsthesiometer tube so as to present an adjustable length of 2-6 cm., with corresponding stimulation values ranging from 26 to 2.5 mg/mm (von Frey's tension units), and giving rise in its upper range of intensities to a fair pressure and a minimum of pain. In a few cases a bristle of about 0.33 mm. diameter, 3 cm. long, with a tension value of 36 mg/mm. was employed, the optimal stimulus varying somewhat with the observer and the area investigated.

II. Determination and Verification of Pressure Spots. An area 5 cm. square, situated on the back of the hand or on the volar surface of the arm and near the elbow, was selected for exploration. The locality chosen varied slightly from observer to observer, in every case, however, commending itself by the relative fewness of the hairs and the infrequency of the distracting after-pain or itch which frequently attends stimulation. The hairs on the area chosen (about 2 to 5) were mapped and shaved, and the area explored bit by bit; the observer, who by this time had acquired considerable experience with punctiform cutaneous stimuli, indicated the points at which the resulting sensation squared with his pre-established notion of pressure. The effort was made to abstract as far as possible from the influence of mere sharpness or pain in the formation of these judgments, and the observer employed as criterion the memory-images of pressure developed in the course of previous experimentation.

The distinctive features of this sensation, while practically identical for the different observers, were variously phrased, as "not sharp, but well-defined or well massed;" "a solid core of pressure under the skin;" "muscular feel, deep, lumped-up." The points chosen usually lay to the windward of a hair, as remarked by von Frey.

[1] These two facts (apparently overlooked or minimized by most observers), the existence of bright but fairly painless pain sensations, and the overlapping of pain and pressure stimulus ranges, reveal the untrustworthiness of the customary laboratory direction to map for pressure by means of the clearest and most distinct sensations. The presence of a weak but hardly distinguishable pain must frequently exercise an influence on such judgments.

[2] Later results, harmonizing even more exactly with the definition, were obtained by the device of a quickened thrust of the stimulus hair, or by the application of a pin-point (over the more insensitive pressure bulbs). This latter method seems, on careful reading, to be the approved one for the production of the typical pressure sensation in the writings both of Goldscheider and of von Frey.

Evidence of the stability of the points thus determined was very halting. In spite of the greatest care in marking the skin, and in guarding against errors due to slipping, the point of attack yielding the best granular pressure on one day had often shifted considerably on the next. Repeated stimulation of the point during the same observation period, for the purposes of verification, often resulted in the substitution of a piercing pain for pressure. Finally, in re-examining the area with weakened stimulus intensities (at the expense, of course, of the genuine "granular pressure" quality), it was frequently noted either that the points of greatest sensitivity under these altered conditions did not coincide with the marked pressure spots, or that points of equally vivid sensibility were discoverable in the intermediate areas. The quality of these intermediate points, under the conditions, was bright but not painful.

III. Electrical Stimulation of Pressure Spots. Weak faradisation of the region above the hair follicle was then resorted to, as possibly more efficient than mechanical stimulation for the exact determination of the position of the pressure spot. To our surprise, the first sensations to emerge with increase of current were not those of pain, as the observations of von Frey had led us to expect, but certain shadowy, quivery shreds of sensation, which with increase of the current became a sharp tremolo or tingle, totally foreign to the specific pressure quality adopted as the standard in our observations. With continued increase of current, these pricking, tingling sensations seemed to fuse into a sharp tearing pain, which, however, rapidly died away. We sought in vain for anything corresponding in our estimation to the throbbing pressure sensation reported by von Frey as the characteristic occurrence. The only suggestion of a pressure response reported by the observer was an occasional dull areal pressure of considerable extent, usually referred by the observer to the contraction of the muscle fibres of the skin, and not intermittent but steady, lasting even after the removal of the electrode; or a very deep dragging pressure, seemingly below the pain zone and hardly distinguishable from ache. The term 'pressure' was here, however, obviously applied in its popular objective sense, not at all in the restricted technical significance given it in this article. A similar criticism applies to the throbbing pressure which was finally obtained from the gums. It was obvious, then, either that electricity could not be employed in mapping, or that we had somehow gone astray in our selection of the typical pressure sensation.

IV. Comparison of Pressure Sensations from Different Areas. Examination was then made of isolated pressure sensations from different regions, in order to discover whether the sense

contents which we had adopted was really typical or was merely an artifact, dependent on the composition of the tissues, etc., in the regions stimulated. Pressure sensations from the palm, the gums, the lips, and the hair-bulbs of the calf of the leg were examined and compared with those from the arm.

Striking differences immediately became manifest. From neither the palms, the gums, nor the lips could a truly granular, "lumped-up," "compacted" quality be obtained. From the mucous membrane of the gums only a bright sensation, verging on pain, and fading quickly into a dull diffuse after-sensation, with nothing of the true granular or knotty character about it, was obtainable. From the palm (where prolonged observation is greatly hindered by the secondary pain or itch sensation accumulating as the result of stimulation for pressure) a 'thrilly,' 'fizzly,' 'boiling' or 'swarming' feeling was the prominent feature. With a slightly different set of the attention, however,—probably on an infinitesimally later phase of the sensation,—a duller, deeper *pressure* would be remarked, and the "thrilly" aspect sensed only as a bright fringe or halo, half ticklish. Rarely, an intermediate stage was caught, when the thrill and the duller core seemed to fuse into something nearer the granular pressure of the back of the hand. This strengthened an interpretation which had already suggested itself, that the so-called 'granular pressure' is a complex, consisting possibly in a fusion of one bright tactual sensation with a duller component, excited by the impact of the hair-bulb or touch corpuscle on deeper-lying nerve-endings.

In case of the lips, also, the sensation is 'tingly' rather than granular and compact. From the pressure spots over the hair bulbs on the calf, which were tested with a sharp pin-point (Goldscheider's method), results intermediate between those from the palm and those from the arm were obtained. The sensation possessed body, tridimensionality, a dullish substrate, but the sharpness aspect, which too often verged on the painful in the case of the arm area, was here milder and in some cases apparently complex, as if a tiny group of bright points were incompletely fused with a certain dull component into something closely approximating the typical granular pressure.

V. Serial Stimulation of a Pressure Spot. In order to examine the sensation differences correlated with different stimulus intensities, and the possible appearance of tickle at the lower limit of the scale, the marked spots over the hair bulbs were stimulated with a series of intensities ranging from 2.5 to 26 mg/mm. Four different series, varying in length from 4 to 15 steps, were given, ascending and descending alternately. At each step in the series the observer was required to give a qualitative judgment.

In the results of all four observers, four apparently qualitative differences made their appearance in succession in the series.[1] Each of these — tickle, contact or brightness, pressure and pain — was correlated with a fairly well defined range of intensities in the stimulus scale. These ranges were, however, somewhat overlapping, and indeed the qualities themselves sometimes appeared in conjunction. Further, the sequence of the contact, pain, and pressure qualities varied somewhat according to the length and direction of the series, a fact apparently correlated with the operation of fatigue.[2] The intensity ranges corresponding with the four qualitative phases were as follows: tickle, 2.5 to 8.5 mg/mm; contact, 5 to 11 (rarely to 22); pressure 8.5 to 26; pain, 25 to 26.

Typical series for three of the observers run as follows:

B.	26 mg/mm.	Pressure, sometimes ending in a painful prick.
	20	Pressure with brightness in it.
	13	Lively pressure.
	8.5	Brightness core.
	5	Diffuse.
	2.5	Tickle.
G.	26	Pressure.
	20	Well-defined sharp contact with pressure below.
	13	As before.
	8.5	Well-defined sharp contact.
	5	Tickle or contact, pointed.
	2.5	Doubtful. Creeping tickle?
S.	26	Pressure and pain later.
	20	Pressure and contact.

[1] The observers were especially cautioned to base their judgments on the immediate sense-experience, and not on subsequent inference or objective reference. The translation of tactual sensation into terms of the stimulus is, however, so ingrained and instantaneous that purely qualitative analysis is greatly impeded. Immediate visualization of the stimulus or of the denting of the skin was the rule; sometimes an interpretation in kinæsthetic or verbal terms was substituted. It is perfectly possible, then, that the descriptive distinctions maintained represent neither disparate sensation qualities mediated by different endings, nor diverse phases within a single qualitative continuum, but verbal associations merely, conditioned primarily by different degrees of intensity and diverse *Gestaltqualitäten*, secondarily by the visual sharpness or bluntness of the imaged stimulus. The intensity explanation seems, however, negligible. Introspection goes to show that, with weak mechanical stimulation, qualitative differentiation of contents is prior to the perception of intensity differences. On the other hand, the dependence of these descriptive distinctions upon unanalyzed complexities of content—due *e. g.*, to the spread of stimulation to adjacent endings, to slight temporal or intensive irregularities, and the like—is a question which demands attention with reference especially to granular pressure and tickle.

[2] Thus contact or sharpness may appear in a descending series only in connection with the first (most intensive) stimulus, instead of extending over its customary range of intensities.

13	Contact.
8.5	Contact.
5	Contact, bright, punctiform, definite.
2.5	Tickle or contact.

The terms in which the different observers phrased their differentiation of the four qualities were as follows. The isolated pressure quality, as obtained from the arm or the back of the hand, is deep, compact, definite, massive or "massed," dull or muscular, easily passing into an ache. "Contact," [1] on the other hand, is superficial, sometimes punctiform, sometimes areal, bright or sharp, shading into tickle at the one end of the intensity scale, into fine sharp pain at the other. More extrinsic points of opposition are found in the temporal aspects of the two. Contact rises abruptly and fades quickly, while pressure is more lasting, dying away slowly into a long dull after-image. Again, as to the degree of projection, of objective reference or localization in the two cases: contact is referred to the surface, with visualization either of the skin area or of the stimulus; pressure, on the other hand, is not projected to the surface, is usually sensed "below the skin" with less precise visualization and localization, but with a certain spatial character of its own, apparently conditioned in most cases by a very vague visualization. Pressure is thus conceived of as having weight, body, bulk, a "lumped-up" or "tridimensional" character, as over against the bidimensional nature of contact or brightness.[2]

A word must be said further on the use of the term 'dull,' and on the possibility that the so-called granular pressure sensation represents not the elementary tactual quality but a complex. Three of the observers showed a tendency to fall back upon the popular use of the term pressure; they associated it with the dull massive sensation correlated with the impinging of any extended solid object on a fleshy portion of the body. Granular pressure, it was discovered, meant in many cases a definite, rounded-off portion of this pressure, welded more or less perceptibly with brightness (contact). A further evidence of the significance attached to the attribute of dullness appears in the statement that pressure "feels as if the skin were dead;" in the greater ease of recognition of pressure spots, when the bright superficial quality had been "fatigued out," as the observer put it; and in the liability to confuse the

[1] More exactly the sensation correlated with moderate intensities; called 'contact' by two of the observers only.

[2] The question as to how far these criteria represent associative factors, correlated merely with degrees of intensity or diffusion of stimulation, will be met later.

light diffuse surface sensation from intermediate areas with weak stimulation of an over-worked pressure organ.—

A brief description of tickle and its relation to contact may here be inserted, though a fuller account will be given in the section on tickle proper. The sensations arising at the lower limit of the stimulus scale were fugitive, vague, elusive as color sensation on the periphery of the retina, and were classed by the observer as 'doubtful,' 'faint tickle' or 'contact'. The distinction between tickle and contact at this level is, in the opinion of the observer, one of objective reference and definiteness of localization rather than of quality pure and simple. Two forms of tickle are distinguishable, in the case of punctiform stimulation; neither bore any obvious resemblance to granular pressure. The first occurs on the palms or lips; it is quick, sharp, lively, akin to pain, thrill-like or vibratory, fairly well localized, but with considerable irradiation and after-image. The second, occurring in the vicinity of hair-bulbs on the arm, hand, etc., is faint (but hardly dull), fine (but hardly distinct), on the surface or just below (but very hazily localized), brief (but usually long enough to display a faint flickering).

Summary of Results

The significant points in these initial experiments may be summarized under four heads:

1. The difficulty of securing an isolated granular pressure without pain.
2. The difficulty in the precise localization and verification of pressure spots; and the apparent existence in the intermediate areas of other spots of approximately equal sensitivity.
3. The inability to reproduce the granular pressure sensation by electrical stimulation of verified spots.
4. The differentiation of pressure and contact (or sharpness) in the introspective results, and the similarity between the latter (rather than the former) quality and tickle.

The theoretical bearing of these facts, and their congruity with histological and physiological data must now be examined.

Theoretical: The Histological Substrate

1. *Original Assumptions.* Our procedure as originally planned was based on the tacit acceptance of certain points in the von Frey doctrine of cutaneous elements.[1] First, the sensitivity of the skin to pressure is, strictly speaking, punctiform. Each point of greatest sensitivity (*Tastpunkt*) corresponds to a

[1] As set forth in his "Untersuchungen ü. d. Sinnesfunctionen d. menschlichen Haut," *Abhandlungen d. kgl. sächs. Gesellschaft*, 40, 1897. The results published earlier, in the *Berichte*, differ considerably in certain important details.

single buried end-organ, either a Meissner corpuscle or a hair follicle with its wreath of nerve endings. The cases in which, on hairy areas, the number of pressure spots exceeds the number of hair bulbs is negligible. The characteristic sensation resulting from the isolated stimulation of a pressure organ is the granular pressure of Goldscheider. Pressure and contact (*Berührung*) are merely different phases of the same quality, the latter fainter and more fleeting. The characteristic pressure sensation may be produced by electrical stimulation of the pressure point, with direct or induced current. Lastly, the sense departments of pressure and of pain are disparate, each possessing its own nerve endings and its own intensive limens.

The task of harmonizing the introspective intricacies of our own observations with this position was an increasingly perplexing one. The most persistent points of discrepancy in our results were as follows. First, pressure and contact (or brightness), as produced by different stimulus strengths on the same spot, differ in quality rather than in intensity proper. Secondly, contact or brightness spots occur in the areas between the pressure spots, and yield sensations which differ from those of the pressure spot (at the same stimulus intensity) in body and complexity, not in definiteness and clearness. Thirdly, the electrical stimulation of pressure spots evokes a kaleidoscopic group of sensations which are individually more akin to the contact or brightness quality than to granular pressure. The appearance of pain in connection with pressure spot stimulation is not in itself incongruous with the von Frey separation of pain and pressure, since good evidence has been brought of the double innervation of the hair follicle; but the existence of a range of weak pain intensities, accompanying pressure spot stimulations and closely imitating contact or brightness sensations, is a fact demanding closer scrutiny.

It seemed probable that differences in method and outlook, in the strictness with which qualitative criteria were applied, lay at the root of these discrepancies. For example, the granular sensation produced by mechanical stimulation of the hair-bulb undoubtedly represents an unique sensory contents. Suppose that, without inquiry into its simplicity, this sense-contents is accepted as the standard, that the limiting value for noticeable stimulation of such points is determined, and that the pressure spots of any given area are mapped upon this basis. Then, even if outlying points existed which, along with an equally vivid sensibility, possessed slightly higher limens, it is obvious that by reducing the trial stimulus-intensity these might be eliminated, and the number be narrowed down to one to a hair-bulb. Further, since the granular pressure sensation belongs uniquely to the spots thus selected, their less distinctive

phases of sensation might easily be overlooked or assimilated to the "granular" contents; and the unlikeness of the equally unique response of the spot to electrical stimulation, together with the existence of the intermediate points of sensitivity, might be dismissed as irrelevant anomalies. The procedure thus outlined is, on the whole, the most straightforward and consistent from the point of view of the physiologist who is in search of definite points of pressure sensitivity. In the absence, however, of corroboratory histological evidence, we are free to consider whether some other interpretation of the facts may not do greater justice to the psychology of the question. The difficulty of reconciling our observations on tickle with the doctrine of granular pressure gave us an added motive toward some revision of our original hypothesis.

2. *Tentative.* At this point of our inquiry the facts seemed to indicate some such schema of the qualitative categories as the following:

a. Pressure and 'contact-brightness' or touch are disparate qualities. Blunt and sharp represent primarily qualitative rather than perceptual differences. The dullness which characterizes the former is not the product of the welding together of a number of punctiform sensations at low intensities, but is an unique sensation quality. It finds a familiar representative in the 'pressure' of everyday speech, the sensation (*minus* its kinæsthetic accompaniments) of a heavy body resting against the skin. The contact quality, on the other hand, is more akin to tickle, and is above all bright, vivid, definite.[1]

b. Contact-brightness and pressure are mediated by different histological elements, the former by fibres ending around the hair follicle and in the more superficial layers of the skin, and very susceptible to fatigue; the latter arising from deeper-lying elements, free endings in the vessels, Pacini corpuscles, muscle spindles or the like. The greater efficacy of pressure over the hair-bulb in the production of the latter sensation is probably due to the concentration of the mechanical effect through the grinding down of the comparatively solid follicle upon the underlying endings. The more superficial set of endings furnishes the sensory data for precise localization and cognizance of the finer detail of tactual impressions, angularity,

[1]The distinction here formulated seems closely related to Meissuer's differentiation of touch from pressure (*cf.* his *Beiträge zur Anatomie und Physiologie der Haut, 1853*); a distinction which it has been customary to dismiss as a confusion of cutaneous and kinæsthetic factors, the passive and the active elements of touch. A similar distinction has been made by Bronson in his discussion of tickle and the persistence in man of a primitive contact-sense mediated by the epidermal fibrillae (*cf. The Medical Record*, XXVIII, 425).

figure, etc., on the analogy of the now discredited "Ortsinn" of the earlier physiologists and psychologists. The other set of endings may be taken to represent the sense which, in conjunction with ache or pain, figures in the passive estimation of differences of weight.[1] Evidence of the histological independence of these two senses may be found in the observations of Head.[2]

c. The so-called granular pressure is not itself an element, but is a complex of deeper pressure and contact as above defined.[3] Hence arises the difficulty of exact reproduction by superficial faradisation of the skin. Hence also comes the disagreement of investigators as to the occurrence of pressure on certain areas where the appropriate conditions for the coupling of these two components of granular pressure are absent, *e. g.*, the cornea.

d. Lastly, it is possible that "contact-brightness" and pain represent not distinct qualities, but shades, so to speak, within the same continuum. The fact that pain arises from intensive electrical stimulation of the hair bulbs might be considered a point in favor of this hypothesis; but the occurrence, under various forms of stimulation, of ambiguous stabbing sensations which introspectively are equally akin to contact and pain furnishes a stronger argument.

The possibility of harmonizing the findings of von Frey with this position is perhaps less remote than might at first glance be imagined. It is not unlikely that von Frey in his investigation of *Druck* or *Tast* has usually in mind the bright, quick quality which we have differentiated from pressure, and that the granular pressure of Goldscheider has significance in his

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[1] Weber's law has been demonstrated only for comparatively high stimulus intensities (100-300 grammes and above). The lower intensities (100 gr. and below) which, according to our hypothesis, would be mediated by the superficial contact endings require different stimulus progressions, and the sensations themselves are subject to a rate of fatigue too rapid for their satisfactory use in difference determinations. *Cf.* H. Griffing, On Sensations of Pressure and Impact, *Psych. Rev. Monograph Supplements*, I, 1895, 30 and 42.

[2] *Cf.* his discussion of the disassociation of deep and superficial pressure following injury to the radial and external cutaneous nerves, *Brain*, 1905, Part 2, 99. While stimulation with cotton wool, or a camel's hair brush is unappreciated, a light touch with the point of a pencil, the head of a pin, or the tip of the finger is immediately sensed.

[3] The difficulty of isolating cutaneous sensation from that of the underlying tissues is commonly conceded. The question at issue here is somewhat different, inasmuch as it concerns the complexity, not of the whole sense-contents attending mechanical stimulation, but of the granular sensation in itself. At this point of our analysis, we were inclined to regard the deeper component as the unique factor differentiating granular pressure from the sensation of intermediate points.

system rather as an unique pressure-spot experience than as the ultimate qualitative unit. His classification of paræsthesias, tingling, and electrically excited sensations with pressure or *Tastempfindungen* seems, indeed, to point to this conclusion. Again, with regard to the differentiation of dull and sharp, von Frey himself in a recent statement[1] has recognized the distinction between touch and deep pressure as valid, conceding the conclusiveness of Head's evidence, and suggesting the muscle spindles, or the Pacini or Golgi-Mazzoni corpuscles as the terminal organs for the latter quality. Lastly, as to the number and distribution of touch points and the status of the intermediate points yielding only bright (not granular) sensations, the original *Berichte* reports would seem to agree fairly well with our position. The reduction of the number of spots to the hair, in the *Abhandlungen* and in Kiesow's later work, is the result of a more or less arbitrary lowering of the test intensity (from 4 to 0.5 mg/mm) in different cases.

So far, then, our proposed revision has found no essential contradiction in the observations of von Frey. It remained only to submit the schema to the test of experimentation. The modification which the hypothesis underwent in consequence will be discussed later.

Further Investigations and Résumé of Results.

If pressure and touch actually represent not different intensity phases of the same quality but discrete modalities, experimentation should be able to show that the two vary independently, are affected differently by fatigue and drugs, possess different limens, and probably differential features in the conditions of their adequate stimulation in general. Even if their terminal organs are frequently associated, some cases ought to be found in which the points of greatest sensitivity are not identical; and, to eliminate the explanation of the quality differences in terms of intensity, the two should be shown to occur not only in isolation with the same stimulus intensity, but also simultaneously at the same point of stimulation. The following series of test experiments were accordingly undertaken.

VI. Mapping the Pain, Pressure, and Contact Points about the Hairs. Testing with Serial Stimulation. For the first purpose the æsthesiometer, at an uniformly high intensity, was employed. The results went to show that the points of greatest sensitivity for the different qualities are usually distinct When a series of graded intensities is applied to the different spots, contact-brightness and pain sensations usually emerge

[1] *Cf. Jour. Amer. Med. Assoc.*, XLVII, No. 9, 1906, 647.

at the appropriate stage in every case, but on the pain or contact spots a dubious pressure or none is reported.

VII. Mapping for Pressure, Contact, and Tickle with Stimulus Intensities of 25, 15 and 10 mg/mm. A new hair, 0.23 mm. in diameter, was used. It gave in general its best pressure, contact, and tickle at the above intensities. Mapping was facilitated by the discovery that a quick short stimulation gave the best contact, while a more leisurely setting down and removal of the hair gave the more definite pressure. The tickle spots were found to coincide with the pressure rather than with the contact spots. Lifted folds of the skin and the region over the knuckles were also tested for pressure, which was easily obtained from the latter, but was apparently lacking in the case of the former.

VIII. The Occurrence of Pressure and Contact in Conjunction in Certain Cases, in Disassociation in Others. In the first case, prolonged stimulation with a blunted point, in the other the application of a series in the manner above described, was the procedure. In a large number of cases the observer reported the appearance of the two qualities together; sometimes the one, sometimes the other came out in advance, in accordance, apparently, with the direction of the attention. In a certain number of cases the contact reported later was probably a weak phase of a secondary pain. In the disassociation experiments, in which the area examined was first fatigued to pressure or rubbed with cocaine, the contact or brightness quality always suffered, while deep pressure was not only not at all weakened but apparently came out the more clearly in the absence of the superficial brightness.

So far, the results seemed sufficiently in harmony with our hypothesis. But the query now began to press as to the significance of what we have called our brightness or contact spots, occurring between the hair bulbs. Are these on precisely the same footing as the spots over the hair bulbs? Do they not possibly represent the free epidermal endings, *i. e.*, the pain spots of von Frey,— the contact or brightness quality being merely a fainter intensity of that sensation? The accidental discovery that superficial pain adapts out almost as readily as superficial contact gave further incentive toward the examination of this phase of the problem. The concluding experiments, which brought us ultimately to a more satisfactory conception of the quality of pressure, were devised more especially in the interests of this question.

IX. Mapping for Pain and Testing for Contact-Brightness. Precautions were taken to ensure the discovery of all the super-

ficial pain points on a given area of the arm; the skin was softened and a finely pointed needle was used. It seemed to us quite likely that so-called cutaneous pain is mediated by two sets of endings: the intense but quickly-fading variety by the epidermal nerve endings, the more severe and lasting (including ache and possibly secondary pain) by deeper (possibly vasomotor) endings. Our brightness sensation, if related to either, was most related to the former set. Hence in mapping we were careful to permit the point of the needle to penetrate only the superficial epidermal layers. After a due period of rest, the points so mapped were examined with the hair æsthesiometer (at about 23 mg/mm.), and were found to give in many cases the typical brightness (contact) sensation; in others, contact followed by a point of pain; or thirdly, where the epidermis was evidently injured or the region beneath had reddened, a pain which tended to outlast stimulation.

Later, in retesting for pain, the responsive point was often found to have shifted slightly, in a way corroborating Thunberg's hypothesis of an areal pain sensitivity corresponding to a tiny cluster of brush endings. The shifting would then represent the successive fatigue of endings within the same brush.[1] Mapping of the same area for pain with an overheated brass point, lightly applied, gave practically identical results as regards the position of the points and the occurrence of fatigue. That superficial heat pain is mediated by fatiguable nerve-endings is, of course, indicated by the rapid decrease of pain intensity on plunging the hand into a bowl of hot water. That this represents peripheral fatigue, not a mere loss of conductivity in nerve fibres in general, is indicated by the retention of other sensations, especially certain vivid (but unpainful) superficial sensations of pricking or tingling.

X. Mapping for Contact-Brightness and Testing for Pain and Pressure. An experiment complementary to IX. was then performed on a fresh area. The hair æsthesiometer at a length representing about 16 mg/mm was used; but in order to avoid a secondary pain response it was set down gently, and probably its effective intensity was somewhat lower. The points giving a clear brightness sensation were mapped, about 16 for an area of 3 by 10 millimeters, or approximately 50 to the square centimeter. This number is rather too large for the pressure spots of the area (on the volar side of the arm), and too small for the

[1] The possibility of fatigue in undifferentiated endings runs counter to current dogma, but there is (so far as the writer knows) no histological or physiological evidence of its impossibility in the case of the free epidermal endings; especially if, as seems probable, mechanical excitation itself is effective only through the production of chemical alteration in the nerve tissue.

pain spots, according to the calculations of von Frey. The area was next tested with a wooden point; some three or four of the marked points gave, not a single sharp sensation, but an obviously complex multiple of such sensations which was recognized as granular pressure; the others gave merely sharpness or a vague diffuse sensation. The hair æsthesiometer at 24 mg/mm intensity gave approximately the same results, the single points, however, becoming almost painful. The needle used in IX. was then applied gently to each point. Nine of the marked spots gave a lively pain immediately, sometimes, however, displaying an infinitesimal shifting of the point of greatest sensitivity. The rest gave granular pressure or nothing, while as many new pain points (about 16) again came to light in the gaps.

So far, then, it seemed clear that the bright component of granular pressure is fairly indistinguishable from the sensation arising from a weak stimulation of a superficial pain point; and, further, that the existence of contact points independent of pain and pressure spots is untenable. The question of the varying complexity of the sensations arising from hair-bulb stimulation, in comparison with the uniformly simple sensations arising from intermediate points, is one that requires further examination.

XI. Mapping with Electricity for Pain and Pressure. The interrupted current was used to explore an area on the lower arm. The indifferent electrode was bound to the arm with a damp sponge; the stimulating electrode was a fine point of copper wire. With gradual increase of the current, the observer reported the first appearance of sensation directly over the hair bulb as a faint "whirr" or cobwebby flutter or flicker, at times almost ticklish. Sometimes a brief stab, single or barely oscillatory, could be obtained from the intermediate regions with the same intensity of current. With approach of the primary and secondary coils the vague "whirr" over the hair bulbs became a "buzz," a complex tremolo of sharp, almost painful, points. Two such points of equal sensitivity were usually found in the vicinity of the same hair bulb. A similar response occurs in the intermediate regions only when the electrode is applied over a vein or artery, or when the current is strong enough to diffuse to neighboring hair bulbs. The sensation evoked in the interstitial spaces is usually sensed as a sharp, quick pain, immediately disappearing or fading into a weak, sharp tremolo or trill, quite different from the complex seething of hair-bulb stimulation. The pain itself, if not too sharp, may be perceived to possess an oscillatory rather than a steady character.

If the current is again increased, and fatigue of the area is avoided, the sharp "buzz" over the hair bulb seems to fuse into a tearing, rending pain, uneven, not perfectly continuous, and rapidly fading into a series of wrenching pricks which (while actually painless) excite a strong and almost reflex tendency to withdraw the arm. The pain thus evoked from the hair bulbs is strikingly different from the pain of the single intermediate points, which is fine and wirelike, while this is less abruptly penetrating but indescribably 'wrenching.' A similar distinction was made by one of the observers with regard to the pain produced by bristle stimulation of the hair-bulb and the intermediate regions. The former was characterized as sparklike, branching, explosive, aching, or dragging, the latter as wirelike, piercing. This difference is obviously less one of quality than of complexity, and the possibility is suggested that just as the granular sensation represents a synthesis of sharp points, so the hair-bulb pain represents the fusion of a number of single pain sensations.

In the course of this experiment, the discovery was made that a brief down-setting and removal of the electrode (with a moderate current) produced a fair imitation of the granular pressure of certain regions. This gave rise to the suggestion that the hitherto puzzling electric sensations from the hair-bulb represent merely a disintegration of the sharp component of the granular pressure, *minus* its duller, deeper substrate; and, further, that this sharp component represents the essential factor in granular pressure, the idea of compactness or solidity being derived from the manifolding and fusion of these components in the case of mechanical stimulation.

With the practice in analysis gained through these observations of electrically excited sensations in different complications, at different rates and at different points of fusion, the pressure sensations arising from mechanical stimulation on different areas were again passed in review, and a final estimate of the true pressure quality was attempted.

XII. New Introspections on Granular Pressure. From the cornea and conjunctiva no pressure, granular or diffuse, was obtained. Hairs of different sizes and loops of silk thread were used for the test. Sharp, punctiform, painful sensations uniformly resulted. The conjunctiva was less acutely sensitive, but the aching, areal sensation sometimes there evoked could never be identified as a dull pressure. The only tickle obtainable was painful.

On the mucous membrane of the mouth a good granular sensation could be obtained only by thrusting in the point of a needle. From the tongue, the hair æsthesiometer called out

only a sharp sensation, but by fusion with an aftermath of apparently reflexly excited sensations in the neighborhood this yielded a fair imitation of the granular sensation.

The observation that the "crunching" characteristic of granular pressure was best called out by stimulation over a bony substructure or on a calloused surface was now supplemented by the accidental discovery that on reddened or swollen areas the light, quick application of a needle point or hair gives, between the hair-bulbs (especially if the area is already fatigued to pain), a complex of unpainful, sharp sensations equivalent to a granular pressure *minus* the dull, deep component. If this sharp, thrill-like aspect of the pressure sensation were taken as the essential component of cutaneous pressure, the difficulty of classifying tickle as well as the electrically excited sensations with the cutaneous sense would lapse; the three would represent merely different spatial, temporal and intensive arrangements of the same elementary brightness sensation.

General Conclusions

1. *The Elementary Tactual Quality and the Histological and Physiological Conditions of Its Occurrence.* Three points out of the above observations are of special significance to our purpose.

(*a*) The complexity of the "brightness" component in granular pressure.

(*b*) The similarity of weak pain to any one of these bright components taken singly.

(*c*) The probability that these brightness components represent the essential, *i. e.*, the typical feature in granular pressure, and that the dull substrate which accompanies it under certain conditions is a secondary and probably a non-cutaneous factor.

Weighing these considerations, in common with the introspective evidence of Section B., we suggest that a single brightness or contact impression be considered the tactual unit. This qualitative unit, appearing in various groupings and intensities, may be sensed as granular pressure, contact, tickle, possibly even as pain. The bright, quick thrill of a light touch, and the stinging but unpainful sensations from twisting massage, may be considered as familiar representatives of this quality.

Physiological and histological conditions probably determine the variations in the form or pattern in which the tactual quality appears. The histological substrate of the sensations of light pressure is probably the Meissner corpuscle or the nerve endings of the hair follicle. The feature in common in the two

anatomical structures is the concentration of the terminations of one or more nerve fibres within a small space, accessible to stimulation from a limited skin area only. In the Meissner's corpuscle branches representing two, three or even more neurones (in the case of the larger corpuscles) break up into a complex network of varicose branchlets within a connective tissue capsule. In the case of the hair, only one nerve fibre as a rule reaches each follicle, at about half the distance down the root from the surface of the skin. This divides into two branches, from which numerous varicose fibrils proceed upward for a short distance parallel to the axis of the follicle, terminating apparently outside the glassy layer, that is, outside the solid structure of the hair root.[1]

Now, whatever may be the mechanical or molecular changes within the surrounding tissues which condition an excitation of these endings, it seems likely that the endings within a group are capable of individual response, that they may be excited singly, in irregular succession, in varying patterns and in different intensities, according as stimulation reaches them in the form of a single prick from the point of a needle, a light thrust from a blunter object, or the passage of an electric current. Possibly the chances of irregular stimulation are increased by some tendency toward periodic alteration in the adjoining tissues, *e. g.* through the vibratory movements of the hair or hair root. It is also possibie that the endings are accessible to stimulation from more than one point on the overlying skin,—a possibility confirmed by our discovery of two to three points of almost equal sensitivity in the immediate vicinity of the hair follicle.

That the sensation resulting from the stimulation of such an ending singly should be identical with the quality resulting from the excitation of a free epidermal ending contains nothing *a priori* improbable. Histological evidence of the differentiation of the terminal fibres of either set of nerves is lacking; and, further, it has been shown that the hair follicles in general receive their nerve supply from the same fibres as terminate in the immediate skin area. While differentiation of quality is sometimes assumed to be centrally rather than peripherally conditioned, it would seem probable that the original motive to such differentiation sprang from some peripheral stimulus difference. Now the adequate stimulus of both pressure and pain is mechanical, differing only in area or penetrativeness and in intensity. While this difference is of the highest biological significance (since highly intensive stimuli are almost uniformly injurious to the tissues), it seems possible that it is amply represented in the interests of biological functioning and of protective reflexes by the functional and anatomical independence of the two sets of nerves, for pressure and pain proper. In the one case (that of the epidermal endings) we have great accessibility to such external stimuli as would tend to pierce or

[1] A. A. Böhm, M. von Davidoff, and G. C. Huber: Textbook of Histology, 1904, 393-4.

penetrate the skin; in the latter (hair wreath or Meissner corpuscle) we find an arrangement whereby the endings are both protected from excessive stimulation and fatigue, and fitted for the perception of the faintest impressions, through the multiplication of the number of endings distributed within a minute space or by a special device (the hair) for magnifying the mechanical effect.[1] This anatomical and functional separation of the two sets of nerves insures, of course, distinct reflex arc connections for the two grades of stimuli.

From the point of view of consciousness, the distinction between blunt and sharp (*i. e.* the areal difference in stimuli) is provided for by the complexity or simplicity of the resulting sensory process in the two cases, the sharp response (from pain or pressure organs) being possible only with sharp and penetrating or pointed objects, the granular or pressure sensation arising ordinarily from objects presenting some surface. The distinction between extremes of intensity may possibly be represented by a qualitative distinction dependent not on differentiated endings but on independent central stations for collaterally and directly conducted impulses; the collateral connection would then lie open only to high stimulus intensities. In any case, the motive for qualitative differentiation of pain and pressure within their lower range of stimulus intensities is not conspicuous, and this is the point with which we are here concerned. Upon the actual fact of the likeness of the simple tactual quality and the distinct but painless response of a pain spot to moderate stimulation, we believe the testimony of introspection to be sufficient.[2] The readiness with which the latter sensations pass over into positive pain has doubtless contributed to screen them from comment.

To return to the pressure-unit concept, and to recapitulate: the granular pressure of Goldscheider was, as our introspections showed, a complex sense-experience. The desirability of retaining within the category of pressure such semi-disintegrations as tickle and electrically excited sensations forced us toward recognition of this complexity and revision of our pressure-concept. In the accomplishment of the latter task we have discarded the dull substrate of the granular pressure of our earlier observations as an inessential concomitant of cutaneous pressure, having its origin probably in the subcutaneous tissues.[3] Abstracting from this deeper component, we find the isolated skin pressure still complex or "granular," made up apparently of a number of simple tactual impressions whose description is impossible except by such adjectives as sharp, bright, punctiform. The application of the term 'pressure' to this sensation seems unfortunate, since the prominent component in the 'pressure' of ordinary speech is undoubtedly not

[1] *Cf.* W. Wundt: *Physiologische Psychologie*, 1902, I, 400.

[2] The existence of a range of fairly unpainful pain sensations, corresponding to the response of the pain endings to a lower range of stimulus intensities than is usually thought possible, is of interest more especially in relation to the origin and explanation of organic sensation, in connection with which it will receive fuller discussion in a later article.

[3] The question of the uniqueness of its quality is reserved for later discussion.

the granular quality but the deeper element which we have just thrown out of the discussion. The expression 'light pressure' or 'touch' would seem to be the least ambiguous.

Careful examination of Goldschieder's monographs on cutaneous sensation reveals many unexpected congruities between his observations and our own. In the interests of the doctrine of specific energies, we find many qualitative phases of cutaneous sensation carefully examined and recorded. Among these are certain trenchant descriptions of pressure-spot stimulation, phrased in terms which are a tacit recognition of the complexity of the so-called granular sensation. The characteristic feeling is "kein eigentlich punctförmiges" but "als ob man auf ein feines Körnchen Staub druckt";[1] "wenn man auch nicht sagen kann dass er flachenhaft irradiiert wie bei den Temperaturpuncten, so ist er doch breiter als zum Beispiel die stechende Empfindung, welche in der That als punctförmig zu bezeichnen ist. Man könnte das Druckpunktgefühl vielleicht als ein dem punctförmigen nahekommendes aber volleres Gefühl bezeichnen."[2] The discovery which Goldscheider here believes himself to have made is that the pressure sensation, even in the last analysis, is not punctiform but retains its characteristic pressure quality, *i. e.*, its spatiality, solidity. This solidity, of course, we should maintain to be, not a characteristic of the ultimate unit, but a correlate of the complexity of the granular pressure itself.—

This point comes out more clearly in the contrast drawn between pressure-point stimulation and that of intermediate regions. On the latter the sensation is either "ein mattes unqualificiertes," or on certain points, with sharper stimulus, "mehr stichartig, das heisst, ohne Schmerz, aber auch ohne die qualificierte Tast- und Druckempfindung, dünn, inhaltlos." This "stechende Gefühl" of the intermedite points, which with increased intensity easily passes over into a painful prick, corresponds evidently to our bright sharp sensation, and the points on the skin to our original contact points. These points were at first distinguished by Goldscheider from the pain points proper, but the distinction was later recognized as one of limen only, and the two were grouped together and referred to the *Gefühlsnerven*. This setting-off of *Gefühlsnerven* from *Drucknerven* corresponds, according to Goldscheider, to a functional rather than a qualitative differentiation. It represents a separation of function in the perception of the objective as over against the subjective aspect of experience. The *Gefühlsnerven*, branching everywhere in the skin, render

[1] Gesammelte Abhandlungen, I, 1898, 187.
[2] *Ibid.*, 191.

it sensitive to mechanical stimuli in general and to intensive stimuli in particular. The specific pressure-nerves, on the other hand, are especially adapted to the perception of low intensities and intensive differences, and of small differences in locality.

The pain into which this "punktformige" quality, produced by the stimulation of the *Gefühlsnerven*, goes over with increase of intensity is described as "ein schmerzhaft stechendes, welches durchdringend, lancierend, und meist in Moment des Entstehens am stärkesten ist, um trotz Fortdauer des Reizes schnell zu erlöschen." The painful excitation of a pressure point, on the other hand, makes a more powerful impression on the sensorium, lasts as long as the stimulus, with a tendency to grow stronger rather than to weaken.[1] The passage in this case of the granular pressure into pain is described as a transition into a "ziehendes, druckendes, quetschendes Schmerzgefühl," as over against the "stechartiges lancierendes" of the intermediate points; a distinction similar to that made by one of our observers.

According to Goldscheider, then, there are two sets of points on the skin, of which the one may yield a *Beürhrung* (or *Kitzel*)-*Druck-Schmerz* continuum, the other a *Berührung-Stich-Schmerz* series, the former mediated by *Drucknerven*, the other by *Gefühlsnerven*. The precise relationship of the *Druck* and *Stich* qualities (both of which are said to shade into pain at the upper end of the continuum) is left uncertain. Pain, when not too intense, is said to have "gewisse verwandtschaftliche Beziehungen zu Berührungs- und Druckqualitäten," but the anomaly of its appearance at the summit of two disparate continua is left unexplained (unless the hypothesis of gray-matter conduction in either case be taken as an explanation). Our interpretation, while doing justice to the shades of similarity and difference noted by Goldscheider, would simplify explanation by reducing the distinction between the *stichartiges* and *körniges Gefühl* to one of complexity and not of quality, and by assigning certain aspects of so-called pressure to deeper, non-cutaneous endings.

A word may be added in conclusion, in support of our proposed simplification of the pressure concept. It may be objected that to push analysis beyond the normal functional unit, *i. e.*, granular pressure, is a work of supererogation; a sense contents is practically unitary as long as it evades analysis, and this the granular pressure normally does. In reply we can only urge that a unit which may go to pieces in the hands of the experimenter is, under any conditions, an unsatisfactory basis of op-

[1] *Op. cit.*, 198.

erations. To be useful in investigation, a unit must be not only unanalyzed but unanalyzable, as our difficulty in identifying tickle and electrically excited sensations with the pressure quality has shown. Further illustrations of this point may be drawn from the sphere of semi-subjective sensory complexes, cutaneous and organic, where the danger of mistaking what we may call (in analogy with *Klangfarbe* in tones) the form-color or quality of a sense experience for ultimate qualitative contents, *i. e.*, for a new quality, is constantly present. In accordance with our original purpose, we insert under the next heading a description and tentative analysis of some of the simpler of these complexes as encountered in the study of pressure.

2. *Form-Color: The Apparent Metamorphosis of Sense Qualities through Elaboration.* For the study of apparent alterations of quality through reduplication and complication, stimulation of the skin with the interrupted current is invaluable, affording, as it does, from moment to moment transition phases in the formation and disintegration of fusions and complexes. The conception of granular pressure as a fusion of points on the verge of disintegration because of temporal or intensive oscillations, and the possibility that just as granular pressure represents a half-fusion of sharpness-units so dull areal pressure represents a smooth fusion of low intensities of the same units, were suggested by the use of the interrupted current.

a. The Qualitative Validity of the Term 'Dull.' Even if the dull component of our original granular pressure arises from a distinct set of deeper endings, its qualitative uniqueness is by no means assured; it may represent merely a blurring together of sensation-units similar to those of our superficial tactual quality. Attention was drawn to this speculation by the following observations. First, the after-image of a "fizzly" or ticklish pressure, *e. g.*, the sensation resulting from a light thrust on a swollen and reddened area or the palm of the hand, often approximates the dull, "cottony" unanalyzability of our deep pressure. Secondly, with continued faradic stimulation of the skin, a certain zone of sensation tends to lose its prickly intermittent character and to approach the dull areal pressure quality. A similar experience follows the holding of a finger against the vibrator of an inductorium or the end of a tuning fork; at a certain point of fatigue and dulling of the original bright intermittent sensations, the disparate vibrations become more and more indistinguishable, until finally the complex falls just below the level of analysis and a dull smooth areal impression succeeds. A similar gradation into dull pressure occurs in the dying away of the tingling of a limb which has

been "asleep" into either a massive dull sensation or a mass of soft blurred barely analyzable fluttering sensations. That is, the appearance of a dull massive contents marks apparently not the transition to another quality but a stage in the amalgamation of otherwise punctiform sensations. Hence the dull pressure of ordinary speech, even if mediated by deeper endings, conceivably represents not a quality peculiar to them, but a fusion of sensations like in kind to our elementary tactual quality, but of moderate intensity (the endings being secured against violent stimulation) and continuous, not irregular. That is, dullness may represent a certain "form-color" rather than a primitive quality: the terms massive, solid, may refer less to intrinsic qualitative attributes than to associated imagery, such as the hazy visualization of the tridimensional objects by which the displacement of deep pressure is ordinarily effected, or to a vague consciousness of the spatiality of the region of the body affected.

b. Sharpness. A similar query as to the status of the adjective 'sharp' rose in connection with the characterization both of tickle and of electrically excited sensation. The possible interpretations fall into two main categories: either sharpness represents an original quality, hardly susceptible under any conditions to clouding and blurring; or sharpness is simply a function of the isolated appearance of a sensation, hence capable of attaching itself to any quality indifferently. The latter possibility is itself susceptible of various explanations, *e. g.*, the following:

(1) Sharpness or pointedness may represent the opposite or absence of extendedness. Extension or surface may be an associative factor, visual or kinæsthetic, set up only when the stimulation affects two or more points. Hence pointed or sharp would be the equivalent either of absence of visualized extent, or of visualization of a single point.[1]

(2) Sharpness may denote the absence of the fringe or halo of weaker sensations usually present as a result of the diffusion of stimulation to adjacent endings. In other words, it may represent not an attribute of sensation but a relation to other contents, *i. e.*, definiteness of outline, or sharpness of differentiation from the context.[2]

(3) Sharpness, in its cutaneous application, may signify merely abruptness of rise and fall of sensation, clean temporal definition; correlated in tickle with the oscillating intermittent

[1] We have no intention here of raising the question of the spatial attribute as intrinsic to the tactual sensation. The point at issue is merely the presence or absence of an appreciable *surface*.

[2] Sharpness in this sense is practically equivalent to 'distinctness' in the usage of Wundt.

character of the sensations, in contact or light touch with abruptness of appearance and disappearance, in contrast with the gradual swelling out and dying away of a dull, heavy pressure.

(4) Lastly, sharpness or brightness may connote merely a vividness, penetrativeness, correlated with the concentration of attention on a single process as against its customary dispersion over a total contents representing several processes. For example, the sharpness or vividness of a pain sensation may be largely a function of its monopoly of the focus of attention.

As the result of many observations the decision was finally reached that the contents described as sharp is really the *typical tactual quality*, capable, to be sure, of definite dulling or brightening, under the influence of variations either in intensity or in any one of the four conditions above listed.

c. Principal Types of Form-Color in Tactual and Kinæsthetic Sensation. Parallel with the above study, the working over of a number of introspections on sensory complexes akin to the organic (accumulated in connection with the analysis of granular pressure and tickle) was attempted. The plan adopted was to select certain of the specific sense-experiences arising from the excitation of the skin and immediately underlying tissues, to examine the transitional phases, and to determine how many of the differences accepted at first sight as ultimate resolve themselves on analysis into differences in the consolidation or co-ordination of the component sensations. The gooseflesh shudder, the tingling following a sharp rap on the hand, the "waking up" of a limb which has been asleep, and the ordinary muscle, joint, and strain sensations were carefully observed in their waxing and waning,[1] with the results recorded below.

The sensation of stretching or tautness of the skin, common to certain stages of the gooseflesh shudder, electrical excitation, and the after-phases of the sensations associated with tickling and a smart blow on the skin, we were at first inclined to regard as a specific quality, having its origin in the sensory endings in the plain muscle fibres of the skin and excited by the contraction of the latter. Since, however, this unique sense-experience was observed always to accompany the dying away of an extended field of sharp intermittent sensations, the suggestion forced itself on us that this also was a case of peculiar

[1] This procedure approaches as nearly to the "synthetic experiment" as our lack of knowledge of the precise excitatory conditions in the various phenomena would admit. It is, of course, open to objection in that apparent gradations in a homogeneous complex may really mean the gradual swamping of one quality through the emergence of another. The error thus introduced we believe, however, to be inconsiderable with practice in analysis.

"form-color," the mode of appearance in consciousness of an extensive incorporation at a certain stage of consolidation or blurring. That is, the tension in the gooseflesh complex represents a closely woven web of superficial sensation, from which deeper components are lacking. This unique tactual formation, excited ordinarily only by stretching of the skin, serves as a functional unit or symbol for a single objective fact, *i. e.*, tension, and has thus won for itself a solidarity or unitariness which enables it to pass itself off as a specific quality.

A second set of sensations which seemed likely to defy analysis was that of strain. The strain complex, as it occurs in association with vigorous contraction of the skeletal muscles, is distinctly localizable in the tendinous regions near the attachments of the muscles. In comparison with the sense contents of either articular or muscular sensation, it is in its higher intensities unique, and might be characteristically described as suggestive of an iron tension or rigidity. This characteristic contents was, however, observed to occur in other contexts than that of muscular tension or exertion, and in various regions. In the reflex excitation of the salivary glands by sour liquids or odors, in general physical fatigue, in neuralgic headache, in a certain intolerable phase of the tingling of a foot or arm which has been asleep, and after prolonged application of icy objects to the skin, very fair imitations of the tendinous strain quality occur. It seems improbable that in all these cases specific end-organs of strain are affected; and indeed the observations on the transitional phases and gradations in electrical sensations, tingling, and glandular excitation, all go to show that strain, like stretching, represents the welding of a certain group of sensations of the bright tactual quality.[1] As sense contents it differs from stretching mainly in its greater bulk and intensity, and possibly in a greater compactness and closeness of union between its individual members. Here again the unitary functioning of the complex (in tendinous strain) has furthered the specific quality deception.

Thirdly, the sensory contents of the numbness following fatigue or stoppage of the circulation was examined under different conditions, and was found on close scrutiny often to resolve itself into a multitude of dulled unsteady shadowy sensations, giving a total impression of massivity, tridimensionality, but possessing neither the smoothness nor the stability of the ordinary dull pressure experience.

Lastly, the "circulatory" complex or tingling in "pins and needles," the uniqueness of which as conscious contents is

[1] Whether mediated by superficial or deeper endings in any given case is hardly determinable.

unquestionable, was found to present a close parallel both to intermittent electrically excited sensations and to the goose-flesh shudder which, under close observation, is plainly pricking at a certain stage. If we accept the electrically excited sensations as a peculiar disintegration of the granular pressure, and recognize their close similarity to the so-called circulatory sensations, the necessity for forming a special category for the latter lapses, and their uniqueness may be construed as residing not in the individual, but in the aggregate or collective aspect of the complex, the 'form-color.'

In the light of the above introspective evidence it would seem possible to classify these apparent cases of specific quality as complexes or extensive incorporations of varying degrees of consolidation. Three distinct types, representing as many degrees of fusion, may be deciphered. These may be schematically indicated as follows:

(1). The most stable: below the limen for analysis. Two sub-types may be distinguished on the basis of intensity and disintegration: *a*. a smooth fusion or blurring-over of sensations of weak intensity, with incentive to analysis lacking: illustrated by dull pressure or muscular fatigue; *b*. a firm fusion, of considerable intensity, with no tendency to disintegration, illustrated by the sensation of strain.

(2). Of less stability: much blurring and weak intensity, but a slight irregularity or intermittence in single members of the group, which brings the complex just up to the limen for analysis: feeling-tone uncanny, "nervous." Illustrations: numbness, some shades of tickle, the after-image of pressure, the response of a fatigued pressure spot.

(3). Noticeable instability: kaleidoscopic changes; obviously a plurality of sensations, whose intermittence and degree of intensity are both favorable to analysis. Pricking, tingling, and electrically excited sensations are examples.

To those inclined to posit definite boundary lines between pain, pressure, joint, muscle and strain qualities, this attempt to reduce the whole *Gefühlssinn* to a common denominator will seem extreme. Wundt is perhaps at present the sole representative of the school who found in 'touch' a category sufficiently comprehensive for all mechanically excited sensations, external or internal. The tendency of the present is in favor of multiplication of qualities, and the effort to push analysis behind the accepted psychological atoms or indivisibles in the interest of a further simplification of qualities will probably be deemed as fanciful as Leibniz' or Spencer's postulation of unnoticeable part-processes. The dissection here carried out, however, is not purely hypothetical, but was effected in almost every case directly by introspection. Further, while it is un-

deniable that the unlikeness of the experiences cited is functionally more significant than their ultimate homogeneity, work in the new sphere of organic complexes would have been almost impossible without the aid of the concepts of combination or complication thus acquired. From the point of view of method, therefore, such distinction is amply justified.

These supplementary studies have further shed light upon the conditions and significance of certain judgments involved in the description both of tickle and of organic sensation. Before passing to the discussion of tickle, a brief section will be devoted to this subject.

3. *The Sensory Basis of Certain Judgments: Localization, Intensity, Area, etc.* The point here raised is not that of the accuracy of external reference and projection in general, but merely of the reliability of certain judgments as a basis for inference regarding the precise origin and explanation of various phenomena,—tickle, tingling and the like. The question may be formulated as follows. To what extent do apparent localization, intensity, and volume depend directly and unequivocally on sensation attributes and differences? How far are they mediate rather than immediate perceptions, dependent on certain intervening assimilatory ideas and associations,—and thus, for our purposes, open to suspicion? Prolonged introspective study seems to show that visual imagery and stimulus-reference, correlated with variation rather in sensation pattern than in the immediate sensation attributes, form in many cases the important factor.

(*a*) *Intensity.* In the intensity judgments, heavier and lighter, stronger and weaker, variation in the total sense contents enters into the judgment as follows. Even with a punctiform stimulus, variation occurs in the amount of diffusion of stimulation superficially and in the third dimension. Hence the observer frequently reports that the extent to which weaker outlying sensations, or a deeper component, dull pressure or ache, are present forms the basis of his judgment; while visualization of the amount of surface indentation often forms an intermediate link. Interpretation of the stimulus is, therefore, commonly confused with sensation intensity pure and simple. Only thus could the common error have arisen that tickle is characteristically weak and faint as compared with contact and pressure sensations; its customary stimulus is weak, but its own intensity is really in keeping with the energy of the response which it excites.

(*b*) *Spatiality; Extendedness and Solidity.* The distinction drawn by our observers between pressure and touch as tridimensional and bidimensional resolved itself, in the majority of

cases, into a matter of visual association. Bright sensations of a certain intensity and massing are almost indissolubly associated with superficial stimulation, *i. e.*, with the surface of the skin. Whatever is closely associated with visualization of the skin must get thereby (if it does not have it originally) area, bidimensionality. Further, a certain pattern of dull massed sensations is associated in experience with the partial displacement of some fleshy portion of the body, and is never actually projected to the surface. Hence the tridimensionality or solidity of muscle or deep pressure sensations is apparently borrowed from the suggestion of volume in the associated imagery. The significance of the term 'point,' on the other hand, seems to connote an almost total absence of body, of spatiality, and is associated with a lack of projection or objectivity.

(*c*) *Localization in the Third Dimension.* Tickle is sometimes localized "just under the skin," dull pressure always. Secondary pain seems to spring up from below, pins and needles seem to dance to and fro in the third dimension, penetrating toward the surface and retreating. Evidence in favor of assigning these sensations invariably to deeper lying endings is, however, lacking. The "depth" perception is dependent on certain habitual principles of objective reference, which, while misleading for our purposes, in the majority of cases work satisfactorily to the organism. The important question ordinarily is not in what layer are the nerve endings affected, but what is the situation of the exciting cause: and the customary spatial interpretation represents with sufficient accuracy the answer to this question. Itch, secondary pain, pins and needles and the like are conditioned immediately by processes within the skin. The immediate incentive to inward localization in these cases is, doubtless, furnished by temporal inertias and irregularities which experience has correlated almost invariably with internal rather than external stimulation.

(*d*) *Movement.* The apparent advance and retreat in the third dimension in "pins and needles" suggest the basis of certain illusory judgments of movement. It seems improbable that the apparent travelling or creeping on the surface for minute distances of the faint tickle-sensations excited by punctiform excitation actually represent either the successive stimulation of different nerve-endings or central irradiation. It is not unlikely that, in analogy with the judgment of apparent movement in pins and needles, slight oscillations in intensity or even irregularity in the successive response of the endings belonging to a single pressure point are interpreted as linear movement on or just below the surface.

(*e*) *Projection in General.* The conditions which determine the completeness of development of projection or objective ref-

erence in any case—*e. g.*, to the body wall, to the body surface, or beyond the surface in visualization of the stimulus—have been indicated under the preceding heads. The conditions which prohibit the passage of a sensory complex beyond the bounds of the subjective, preserving it as an affective rather than a sensory phenomenon, will be discussed at more length in connection with tickle.

Section B. Tickling

Historical: The Problem of Tickle

The peculiar affective reaction excited by a light touch has long been a matter of remark among psychologists and biologists alike. The fact that a feeble stimulus evokes such an exaggerated commotion in consciousness, whereas a heavier one remains indifferent, presents a paradox to psychophysics which has never been satisfactorily explained. The observation that this affective disturbance, which is sometimes pleasant, sometimes uncannily unpleasant, is in some individuals entirely lacking only adds to the difficulties of explanation.

The older psychologists, of semi-physiological bent, threw the burden of explanation upon the obscure concept of "central irradiation," and were content when they had classified tickling with the *Gemeinempfindungen*, the unprojected, ill-analyzed masses of bodily sensation, which function as subjective and affective rather than objective and perceptual. Later, a biological interpretation was attempted, and various speculations were advanced as to the significance in the past history of the race of the reflex vigor and affective response now associated with tickling. Lastly, experimentalists have attacked the problem, and sought to discover in the histology and physiology of the skin, and in the immediate sensory contents of tickle, the peculiar conditions by which it is set apart from cutaneous sensation in general. It is with this latter phase of the investigation that we are here immediately concerned, believing that it alone can afford a satisfactory basis for the explanation of the peculiarities of the tickle consciousness as a whole.

1. Tickle as centrally conditioned, non-projected sensation (Gemeinempfindung *or 'feeling'*).

This type of explanation originated with Weber, but has since undergone elaboration at the hands of Wundt, von Frey and others. The uniqueness of tickling, as of the related experience of gooseflesh, resides, it is held, in the eccentricity of its temporal course (inertia of appearance and disappearance), and in its tendency to diffusion or irradiation. In consequence of these peculiarities, exact correlation between stimulus and

sensation is impossible, and tickle remains among the sensory experiences which fall short of projection beyond the physical self, *i. e.*, among the *Gemeinempfindungen*. With organic sensation proper this failure of external reference may be ascribed to the internal or subjective nature of the stimuli. Tickling, in spite of the external character of its primary stimulus, presents a parallel case; for its actual constituents are secondarily excited sensations (*Mitempfindungen*, in the terminology of Quincke), the temporal and spatial course of which corresponds only remotely with that of the original stimulus.

The mechanism by which these secondary sensations are excited is explained by E. H. Weber,[1] and after him by O. Funke,[2] H. Quincke,[3] W. Wundt,[4] and M. Dessoir,[5] as purely central, an irradiation confined to the sensory centres or ganglia, and referred to the surface only through a special form of excentric projection. Another set of writers, B. Bourdon,[6] M. von Frey,[7] O. Külpe,[8] A. Allin,[9] C. S. Sherrington,[10] and in some passages Wundt favor irradiation from sensory to motor centres. According to the latter theory, diffusion or irradiation, while centrally conditioned, takes effect peripherally, through the agency either of vasomotor changes or of the contraction of the unstriated muscle fibres of the skin. Among the supporters of the vasomotor theory, von Frey and Bourdon admit the possibility that tickle constitutes a specific sense, distinct from pressure, with endings of its own in the skin or vessels, Bourdon maintaining that pleasure itself is a diffuse sensation of tickle. Külpe, on the contrary, holds that tickle contains no new element, but represents a combination of the qualities of pressure and temperature characterized by rapid alternations of contents and intensity, and closely related to tingling and itch. Wundt, in the Human and Animal Psychology, suggests that sensations from the reflexly excited unstriated muscle layer in the skin combine with the feeling of tickling, lending color to the total impression. Sherrington goes further, regarding tickle as "a peculiar psychic elaboration of tactual and muscle impressions,

[1] E. H. Weber: Der Tastsinn und das Gemeingefühl, 1851, 565-6, 578-9.
[2] Hermann's Handbuch der Physiologie, 1879, III, 313.
[3] Über Mitempfindungen, *Zeitschrift für klin. Medicin*, XVII, No. 5, 1889, 443.
[4] Grundzüge der physiologischen Psychologie, 5te Aufl., II, 42.
[5] Über den Hautsinn, *Du Bois-Reymond's Archiv*, 1892, 237.
[6] La sensation de plaisir, *Revue philosophique*, 1893, XXXVI, 225.
[7] Untersuchungen über die Sinnesfunctionen der menschlichen Haut, 1896, 217.
[8] Outlines of Psychology, 89.
[9] On Laughter, *Psych. Review*, X, 1903, 307-8.
[10] E. A. Schäfer's Textbook of Physiology, 1900, II, 976.

the latter arising from the reflex activity of the unstriated muscles of the skin, pilo-motor, sudorific and vasomotor."

II. Tickle as giving rise to affective disturbances and reflexes. In this connection three different explanatory factors have been advanced, the summation of intensities, psychical attitude, and the inheritance of adaptive reflexes.

Summation of intensities. According to E. Kroner,[1] summation of intensities in sensory centres and nervous excitability furnish the explanation of the disproportion between the intensity of the stimulus and the resulting disturbance in consciousness. Allin[2] favors motor rather than sensory summation, quoting Stirling's observation that reflex contractions occur only from repeated shocks in nerve centres. Tickle, he suggests, may represent a sudden convulsive hyperæmia (presumably cerebral) entailing an explosive motor discharge, as contrasted with the diffused hyperæmia of a steady pressure. A possible cue to the difference in the reflex effect of a light and heavy touch is also offered in Lauder Brunton's suggestion that the latter may stimulate two sets of nerves which counteract or inhibit each other.

Psychical attitude. A second possibility has been advanced by C. Darwin[3] and approved by K. Groos,[4] E. Kroner, J. Sully,[5] and others, to the effect that the reflex disturbance of tickling (as evoked in movements of laughter, of withdrawal, and of either protective or purposeless character) is conditioned not by the peculiar characteristics of the initiatory sensation, but by the psychical attitude or disposition upon which such sensations are superimposed. Darwin finds surprise or novelty the all-important factor, and thus reduces the tickle reflex to an expression of emotion. He supports this conclusion by the facts that the parts of the body most sensitive to tickle are those not commonly touched or touched in tickle in an unusual fashion, that the part to be tickled must not be known, and that one cannot tickle oneself. According to Sully, the mental agency conducing to tickle is in the nature of shock or relief: a sense of the unknown or unpredictable in the situation, followed by the recognition of the merely playful character of the attack. Laughter itself is probably a physiological device for

[1] Das körperliche Gefühl, 1887, 164, 200 ff. E. C. Sanford also classes tickle as a summation phenomenon, citing in evidence the fact that a light touch with the prong of a tuning fork is often ineffective when a vibrating prong is immediately productive of tickle. Experimental Psychology, 1898, 18-19.

[2] On Laughter, *Psych. Rev.*, 1903, X, 306 ff.

[3] The Expression of the Emotions, 1872, 201-2.

[4] The Play of Man, 1901, 165.

[5] Essay on Laughter, 1902, 59-61.

the relief of cerebral strain. The stimulation of deeper lying endings is not essential.

A third interpretation regards the reflex response as *the survival from some ancestral instinct*, the significance of which is not perfectly apparent. Various possibilities have been suggested. According to the first, tickle is a relic of a primitive contact-sense, which existed before the development of the senses of 'anticipatory touch,' and necessarily possessed a high dynamogenic value and lively reflexes; when danger was announced only by contact, with great suddenness, strong reactions of escape or resistance were necessary. G. S. Hall and A. Allin[1] and Bronson[2] support this view, the former citing in evidence the fact that the parts of the body most sensitive to tickle are those most vulnerable or most open to attack, *e. g.*, the soles of the feet, palms, and throat, in contrast with the shoulder-blades, calves and thighs. The suggestion is also made by Hall and Allin, and approved by Sully, Sherrington, and others, that the necessity for protection against the incessant attacks of insect parasites has played an important rôle in the maintenance of this sense. A similar explanation is put forward by L. Robinson,[3] according to whom tickle is distasteful or agreeable according as it represents a warning against insect foes or possesses some obscure associations with caressing movements dating back to an early stage of existence.

III. Tickle as a Sense Quality. (*a*) *Relation to Touch.*—In the general literature, tickle is identified more or less closely with contact, touch, or pressure, with itch or with the gooseflesh shudder. Bronson and Dessoir[4] separate touch or contact from pressure, assigning tickle to the former sense; Goldscheider,[5] Kiesow,[6] and L. Herrick[7] classify tickle with pressure, limiting it, however, to cases of a peculiar functioning of the specific pressure organs; Külpe[8] and Wundt, while iden-

[1] The Psychology of Tickling, Laughing and the Comic: *Am. Jour. of Psych.*, IX, 1897, 14.

[2] *The Medical Record*, xxviii, 425.

[3] *Cf.* Tickling: H. Tuke's Dictionary of Psychological Medicine.

[4] *Op. cit.*

[5] Gesammelte Abhandlungen, i, 1898, 45.

[6] *Zeitschrift f. Psych. und Phys. d. Sinnesorgane*, xxxv, 1904, 240-1.

[7] Corollaries of Neurological Discoveries, *Jour. Comp. Neurology*, 1897, 160.

[8] Outlines of Psychology, 89. According to Külpe, tickling often accompanies the weak or intermittent stimulation of a pressure organ. Since a gentle pressure or blowing on the skin is found to be often followed by increase in arterial pressure which intensive or even painful stimulation is unable to effect, it seems probable that "certain processes in the cutaneous vessels serve as the substrate of the impressions of weak pressure and more or less vivid heat which occur in quick alternation in both tickling and itching."

tifying the essential constituent as tactual, recognize the presence of an added element, reflexly aroused by vasomotor or other changes, in the form either of warmth or of muscle sensations.

The distinction drawn by Dessoir between tickle and pressure is really, however, perceptual rather than qualitative and is based upon the absence of externalization in the former sensation; he does not posit a distinct set of endings for his contact-tickle sense. Kiesow identifies tickle unequivocally as a pressure or *Tastempfindung* arising from the direct excitation of a pressure organ, intimating, however, that the stimulation must be accomplished through the medium of the hair, *i. e.*, by vibratory or intermittent excitation. Herrick, though failing to work out any definite conception of the relation between tickle and pressure or touch, explains the diffuse irradiating character of tickle by reference to the anastomosis between tactile corpuscles noted by Dogiel[1]. Goldscheider,[2] while ultimately falling back on a variation of the *Gemeinempfindungen* concept, attempts to explain the peculiarities of tickle by reference to the mechanism and characteristics of the sense department to which it belongs (pressure in his system). While his observations are merely incidental to the investigation of pressure, and are limited to tickle sensations initiated by punctiform stimuli, they bring to light many important facts. Of these the following, since disputed by Alrutz, are noteworthy. First, tickle may appear simultaneously with the sensation of touch which frequently attends it, *i. e.*, a delay between stimulation and the appearance of the sensation is not characteristic. Secondly, there are no specific tickle points; exploration of the skin with a bit of cork discloses tickle only over the *Druck* or *Schmerz* points. Other observations mark the correlation of tickle with weak mechanical or electrical stimulation of the skin: its liability to fatigue; its high affective value and qualitative indefiniteness; its long after-image and the tendency of this after-image to fade indistinguishably into touch; the peculiar distribution of tickle sensitivity, and the inverse relation of the tickle range of any area to its pain and pressure sensitivity. From these observations, Goldscheider draws the conclusions that tickle represents not a secondary sensation, but the direct result of weak mechanical stimulation of the pressure endings, a belief in which Kiesow alone seems to support him.

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[1] *Cf.* Wundt's speculation on the function of the Krause endbulb, *op. cit.*, 13, for a similar suggestion.

[2] *Cf.* Die specifische Energie der Gefühlsnerven der Haut, 1884, 45, 46, 81, 82; and Neue Thatsachen über die Hautsinnesnerven, 1885, 202-4.

The precise manner in which Goldscheider conceives the relation of tickle and pressure differs slightly in the two monographs cited. In the first he maintains that the qualitative continuum of touch or pressure is threefold, comprising tickle, pressure and pain, each representing a special shading, as it were, of the elemental quality. For the production of tickle neither successive stimulation of different end-organs nor repeated stimulation of the same end-organ is necessary; tickle is the "eigentliche specifische Empfindung der Tastnerven" and arises normally from any single weak stimulation of the end-organ. A single stimulation probably gives rise, however, to a whole series of successive disturbances or excitations within the sense-organ. Weak mechanical stimulation is probably the condition most favorable to the uniformity and continuance of this series of excitations, which is perceived as tickle and is pleasant. When the mechanical shock is sufficient to affect the surrounding tissues, the commotion there produced reacts upon the end-organ and either damps off its vibrations or disturbs their regularity. This new state of affairs is transmitted to consciousness in terms of indifferent touch.

On the basis of this hypothesis the correlation of tickle with weak stimulus intensities and its long after-image are readily explained. Two points, however, remain obscure. First, does Goldscheider regard the oscillation ascribed to tickle as a central and conscious matter, or as peripheral and neural merely? Secondly, what is the relation to the system of the apparent irradiation or diffusion of sensation in tickling, which (apart from one casual reference to secondarily excited sensation) is passed over in silence?

Further, it is evident that, from the point of view of the doctrine of specific energies, the association of a three-fold qualitative continuum with a single set of nerve endings has a certain inconsistency. The appearance of tickle as a phase of the *stichartige* and the *körnige* quality in turn, in its character as an exponent of either *Druck* or *Gefühlsnerven*, offers yet another anomaly. The modification of the conception of tickle which appears in Goldscheider's second monograph was apparently framed in recognition of these difficulties. Whether or not it escapes them is matter for discussion.

According to this later view, the distinction between touch and tickle is not merely a matter of qualitative shading but of degree of objectivation or externalization also. Tickle, which is held to arise simultaneously with contact or touch, and preferably but not invariably with the weaker phases of intensity, is not an independent qualitative co-ordinate of the latter, but something *intrinsic to every touch sensation*, an affective shading, as it were, through which the latter is sensed. As in the sphere

of vision, the less distinctly the outlines of an object emerge, the greater is the prominence of the color in which it is clothed, so in tactual sensation, whatever acts to help or hinder projection and definition acts inversely to suppress or heighten the prominence of the affective shading or tickle.

In the earlier monograph, regional differences of sensitivity were referred to the physiological fact of variation in the *Kitzel-*, *Tast-*, and *Schmerzbreite* of the end-organs on different areas; on the specialized tactual surfaces (finger-tips, etc.), the point in the intensity scale at which the quality of tickle passes over into that of touch is very low, on others it is correspondingly high. In the later article, differences in sensitivity are explained on the basis of the use or disuse of the area in question as a perceptive surface, and the fixity or absence of the habit of external reference. Tickle is not simply the sensory effect of the weakest excitation; it is the unprojected, unreferred remnant in every tactual sensation. At first glance this would seem to signify that the simplest tactual contents, as such, possesses both an objective and a subjective aspect, the obverse and reverse, so to say, of the same bit of sensation. Frequent association of the sensation with external stimuli develops the objective at the expense of the subjective or tickle aspect; the unprojected tickle remnant (*Kitzelgefühl*) dwindles.

This as it stands is not unintelligible; although, strictly taken, it is not easily translated into the terms of any psychological system. But Goldscheider's actual understanding of the matter seems to be even more intricate. The simplest touch sensation is not only functionally but is also qualitatively twofold. The split in function runs parallel to a differentiation of contents; tickle is that portion of the contents which never undergoes external reference, the feeling aspect; pressure or touch is the objective or perceptual aspect. With the development of the objective, touch or pressure aspect of the contents, the subjective aspect does not actually dwindle but simply drops into the background, is swamped in the objective. Hence, it is that the feeling of tickle is not absent but is merely in abeyance when tactual surfaces such as the fingertips are lightly stimulated.

This doctrine, taken in detail, is obviously quite as difficult to reconcile with accepted theories of nerve action as was the earlier version. It is, however, highly suggestive, and in the light of further observations a revision of it may be possible.

(*b*) *Relation to Itch*—A close relation between tickle and itch is noted by certain writers. Goldscheider himself suggests that itching is only some more intensive form of tickle. Von Frey [1] is in favor of identifying the two. He refers them to

[1] *Op. cit.*, 217; and Beiträge zur Physiologie des Schmerzsinnes, *Berichte d. math.-phys. Classe d. kön. säch. Gesellschaft*, 1894, 192.

certain vasomotor reflexes set up by touch and thus explains the delay, lack of exact correspondence with the stimulus intensity, liability to fatigue and disappearance of such sensations when the sense of pressure suffers merely a raising of the limen. This conclusion is based largely upon the exclusion from the category of tickle of the weak punctiform sensations recognized by Goldscheider, but classed by von Frey as indifferent *Berührungsempfindungen*. Von Frey expressly restricts the term tickle to the lively, lasting, irradiating sensations, with strong unpleasant tone and a tendency to awake reflexes, which appear in the train of mechanical excitation.

Richet[1] distinguishes tickle and itch only by the external or internal origin of the initiatory stimulus; at the same time, he maintains the close relationship of tickle and touch. Alrutz[2] has attempted, perhaps, the most extended investigation of tickling, but his results also are biassed by a tendency to limit the phenomena under consideration to the semi-painful or itchy phases of tickle. This limitation leads him ultimately to identify tickle with Goldscheider's secondary pain, and to erect out of the two experiences a new sense distinct from primary or pricking pain. The observations which he cites record the results of punctiform stimulation of the cornea, conjunctiva, hard palate, lips, nostrils, and volar surface of the lower arm. Tickle is reported from all these areas, with transitional forms grading into itch from the margins of the lips. The application of a moving stimulus (camel's hair brush) to the lips, forehead, region under the eye, palm and sole of the foot (in the last case a cylinder covered with cotton was used), gave similar results; on the palm the weakest perceptible stimulation gave only touch, and tickle required a slightly higher stimulus intensity. The tongue is also found to respond with tickle when an intermittent stimulus (vibrating fork) is applied. The distinction between deep-seated and superficial tickle (made by Robinson, Sanford and others) is held by Alrutz to be practically non-existent for introspection; the tickle produced by heaviest stimulation of the sole of the foot, apart from the tendency to excite reflexes, differs not at all from the superficial tickle elsewhere.

On the basis of these and other observations, Alrutz concludes that tickle represents a peculiar quality, allied to itching and the secondary pain of Goldscheider. Its distinguishing characteristics, irradiation, diffuseness, indefiniteness and unpleasantness, separate it alike from pressure and pricking pain. For this quality a distinct set of nerve-endings must be posited;

[1] Ch. Richet: *Chatouillement*, Dictionnaire de Physiologie, 1900.
[2] S. Alrutz: *op. cit.*

Thunberg's assumption that the same nerve apparatus, directly or indirectly stimulated, mediates primary and secondary pain in turn is untenable. For this new quality the free intra-epithelial endings present the most likely substrate. The more superficial position and less highly developed structure of these endings explain at once its low limen, inertia, and susceptibility to fatigue.[1]

The following points are offered in support of this hypothesis. (1) Tickling and itching can be obtained only between the pressure points. (2) The limens for tickle, touch, and primary pain are usually different. (3) The latent period for the first is longer. (4) The quality of tickle is nearer that of itch than of pressure, especially in its tendency to irradiation and the production of reflexes; the difference between tickle and itch is mainly one of degree, though the frequent presence of touch sensations with the former usually serves to distinguish them further. (5) Cases are recorded of analgesia without anæsthesia but with loss of tickle. (6) The areas insensitive to tickle and to itch are identical. (7) Areas where pressure and pricking pain are poorly developed possess a strong sensitivity to tickle.

To Alrutz' hypothesis of a specific nerve-energy peculiar to tickle and itch Thunberg[2] opposes the view that these peculiar sensory experiences are completely explicable as modifications of the familiar qualities of cutaneous pressure and pain. Alrutz' evidence on the insensitivity of pressure spots to tickle he regards as insufficient, and explains the 'transitional' forms between tickle and itch as cases of admixture of the two qualities.

(*c*) *Regional Sensitivity*.—The attempt to correlate the peculiar distribution of tickle sensitivity with sensitivity to pain and pressure, or with the richness of nerve-supply, has been made by various writers. Richet declares that the parts most sensitive to tickle, the soles, palms, nasal and labial mucosa, external passages of the ear, etc., are those richest in the filaments of the "*nerfs tactiles*," while Weber, Bourdon, and others maintain that where the sense of touch is most acute or delicate tickle is feeblest, *e. g.*, on the tips of the tongue, fingers, and nose. Weber, Kiesow and Robinson note the relation of the hairiness of the surface to tickle sensitivity, while Darwin and Hall and Allin seek an explanation in extra-sensory factors,—the infrequency of attack or the vulnerability

[1] Curiously enough, Goldscheider makes these very data the basis for the opposite conclusion, *i. e.*, the association of tickle with the *differentiated* organs of pressure.

[2] *Cf.* W. A. Nagel's Handbuch der Physiologie des Menschen, III, 1903.

of the ticklish areas. The sensitive surfaces enumerated by von Frey, the back, the lines in the palm of the hand, and the folds of skin about the nostrils, are obviously related to secondary pain rather than to tickle.

Résumé and Criticism

The writers quoted belong, roughly speaking, to the descriptive and experimental types. The former are primarily interested in speculations regarding the anomalies in the affective tone of tickle and the genesis of the laughter reflex. The latter, of whom Goldscheider and Alrutz are almost the only representatives, are concerned mainly with the qualitative relationships and psychophysical substrate of tickle, Goldscheider identifying it with weak pressure, Alrutz incorporating it in a secondary pain sense. While many observations have been collected, and much advance has been made over the original obscure irradiation-hypothesis and the tendency to mistake weakness of stimulus for feebleness of sensation, further introspective study of the relation of tickle to pain, pressure and the like is now in order. Between the observations of Alrutz and Goldscheider there are, as we have already noted, unfortunate discrepancies, and Goldscheider's conception of the twofold, tickle-pressure aspect of tactual sensation is too ill-defined and hypothetical for unqualified acceptance. In the literature in general a more or less common failure to distinguish between itch, deep-seated tickle, and tickle from a punctiform and moving stimulus, leads to much confusion and contradiction both as to the properties of tickle themselves and as to their interpretation. A further study of the status of tickle as a sense quality, and of its place in the organic or cutaneous continuum, is requisite before any adequate explanation of the peculiar vividness of the tickle consciousness as a whole can be attempted.

Experimental

(*a*) *Peculiarities of tickle to be explained.* The peculiarities by which superficial tickle is set apart from other sensations of the skin appear in the literature above surveyed as follows.

(1) Qualitative indefiniteness and general intangibility.

(2) Relative weakness of the adequate stimulus, and disappearance of the sensation with intensified stimulation.

(3) Susceptibility to fatigue and "excentric anæsthesia."

(4) Inertia and after-duration of tickle sensations as compared with touch.

(5) Diffusion or irradiation of sensation to outlying areas.

(6) Relation to summation, as indicated by intensification of effect with repeated, intermittent or moving stimulus.

(7) Part played by hairs in the intensification or propagation of the effect.

(8) Anomalies in the regional distribution of sensitivity to tickle, which is apparently non-correspondent with the distribution of areas of greatest tactile sensitivity.

(9) Affective tone of tickle, pleasant or unpleasant, and its explanation. Three remaining peculiarities refer especially, though not exclusively, to the deep seated tickle. These are: the disproportionate reflex response to tickle, individual differences in susceptibility, etc., and the relative importance of the "psychic" as compared with the purely sensory in the general phenomenon of tickling.

(*b*) *Points to be experimentally determined.*

The points most urgently in need of experimental investigation or verification may be formulated as follows.

(1) Is the qualitative contents of tickle in any given instance homogeneous, or a complex of unlike components? Does the peculiarity of the experience reside in the sensation itself, or is it to be referred to the general reflex response, as suggested by Bain?

(2) Are the nerve endings concerned those of pressure, pain, the circulatory system, or some new set; and what is the adequate stimulus intensity? Secondary problems arising here relate to (*a*) the distribution of tickle points, and (*b*) the qualitative affinities of tickle.

(3) Is tickle excited directly, reflexly or by central irradiation? Is it simultaneous with touch or delayed?

(4) What is the relationship of superficial and deep-seated tickle; are they qualitatively homogeneous or dissimilar?

(5) What is the distribution of ticklish areas?

(*c*) *Methods of investigation.*

The following series of experiments was carried on in the laboratory in connection with those on pressure, and with the same observers.

I. Qualitative analysis of tickle, and determination of the adequate stimulus for punctiform stimulation. Repeated introspective analysis and comparison of different cases of tickle were undertaken in order to determine the specific quality of the sensation, the possible presence of two or more components (weak pain, pressure, or temperature), and the similarity or difference of the punctiform and moving varieties. A number of areas on the hand, back, arm, and face were examined for the determination of possible qualitative differences. Trial was made of many different modes of stimulation: punctiform stimulation with hairs of varying radii and length, with glass hairs, with a needle; stimulation with a cork point and a camel's hair

brush; successive stimulation with a moving wisp of paper, brush, or bit of cotton; the twitching of the cutaneous hairs; intermittent stimulation with a tuning fork or a bristle attached to a fork; and lastly, the application of a weak faradic current through a blunt or needle-pointed electrode. Paired observations were frequently taken for the comparison of tickle with pain, touch, and contact sensations proper.

II. Mapping for tickle points. The regions especially investigated were areas 1 cm. or 1/2 cm. square on the palm, back of hand, volar surface of upper and lower arm, outer surface of lower arm, and between the shoulders. The adequate stimulus was found to be a light quick touch with needle, cork point, glass hair, or horse hair. The last proved most serviceable; and a hair set in the von Frey æsthesiometer, variable in length from 2-6 cm., approximately 0.2 mm. in diameter, with a grading of 2.5-8.5 gr/mm. was finally adopted. The conditions most effective for tickle seemed to be those favorable to the setting up of a slight oscillatory or vibratory movement in the skin or underlying parts, with as little liability as possible to damping-off by continuous or heavy pressure. The quick snapping back of hairs was particularly effective, while a slow to and fro movement gave only a sense of touch or pressure. The region immediately about the hairs was found the most sensitive; but, as in the case of granular pressure (see Section A), a small group of points rather than a single point of maximal sensitivity was discovered. This area was rather larger for tickle, corresponding roughly to a circle at whose centre the hair emerges from the skin, whereas pressure sensitivity is usually confined to a small segment to the windward of the hair. On a shaved area, however, the best tickle and the best pressure are usually obtained from the stimulation of the same point, the stump of the hair.

III. Determination of the place of tickle in graded intensity series. This experiment was undertaken in order to determine the place of tickle in the intensity series, Goldscheider maintaining and Alrutz denying that it is the first sensation to emerge above the tactual limen. The spots of greatest sensitivity to pressure or contact were located, usually in the close vicinity of the hairs. Each spot was then stimulated with a series of graded intensities; the stimulus hair above described was employed. Qualitative or descriptive judgments were given on each member of the series. As noted in Section A, tickle usually appeared in the lower part of the series but not always at the foot. A stimulus intensity of from 2.5-4 mg/mm. was finally chosen as the most effective for tickle.

IV. Testing and mapping for tickle with variation of the

conditions. Etherized, cocainized, and fatigued surfaces were examined, usually with a moving stimulus, in the hope of discovering a disassociation between tickle and touch or tickle and pain. So far as identifying tickle with either pain or contact was concerned, the results were negative. The etherized surfaces showed a loss of brightness for moving tickle and a tendency toward the substitution of a lasting itching quality (probably reflexly excited) for the usual superficial and quickly fading tickle. There was also a dulling or disappearance of contact sensations as distinct from pressure, and of superficial pain, but apparently not of the pain from deeper-lying endings. A scalded surface explored with a light moving stimulus gave all gradations from a sharp tickle to vivid but quickly passing pain, between the normal margin and the point of severest injury.

In connection with the use of cocaine, the discovery was accidentally made that oiling of the skin brings about a reduction of its sensitivity to tickle. Careful mapping of an oiled area indicates that this is less a case of lowering of sensitivity than of the sharper delimitation of the maximal sensitivity spot to the vicinity of the hair. The explanation is apparently this: the reduction of the elasticity of the skin through oiling disturbs the conditions favorable to the propagation or continuance of the slight vibratory movement usually set up by the light setting down and removal of the stimulus hair.

V. Testing pain and contact points for tickle. The intermediate bright points noted in Section A were tested for tickle with punctiform and intermittent stimulus (bristle on a vibrating tuning fork), mostly with negative results.

VI. Regional sensitivity to tickle. Comparisons were made of adjoining and widely separated areas. The palms of the hands were found to be peculiarly sensitive to punctiform stimulation, the tickle there tending to pass into itch. There is a diminution of sensitivity[1] from the wrist to the shoulder, and the radial and ulnar margins are apparently more sensitive than the intermediate surfaces, and the volar than the dorsal surfaces of the arm. The lips yield a peculiarly poignant tickle throughout a wide range of intensities; the tongue only with the finest of hairs or, better, with a vibrating fork.

(*d*) *General Results*

1. Descriptive. With punctiform stimulation, tickle appears

[1] 'Sensitivity' as here used refers not to the stimulus limen (which really varies little) but to the vividness of response as tested by a considerable range of intensities, the more insensitive areas refusing to yield a lively tickle except with moving stimulus.

in two forms, of which the first occurs in the vicinity of hair bulbs, on areas such as the arm. It usually comes out immediately, but sometimes only after a brief delay, and is hazily localized on the surface or just below it. It is characterized as "a quick kind of contact," rising abruptly and dying away slowly into a long, cloudy after-image, and is sharp or bright in comparison with an ordinary pressure. It is distinguished from contact by its abrupt rise; its moving, creeping character, which apparently causes it to be felt as a line rather than a point; its indefiniteness; and its liveliness, which is usually accompanied by the desire to rub it away. While tickle ordinarily seems to bear no resemblance to dull or even granular pressure, the observer believes that in quality it is hardly distinguishable from contact or light touch, a weak phase of which is often characterized as "just about to be tickle."

The observers generally agree that the judgment "contact" is constructive, associative, or objective rather than descriptive. It refers to consciousness of area, of locality, or of the nature of the stimulus (which is usually visually imaged), rather than to mere sensation quality, which often eludes recall, and is apparently immediately swamped in the objective judgment. The tickle judgment, on the other hand, usually attends an absence of objective reference, conditioned not so much by the mere quality or faintness of the contents as by its unsteadiness or flickering. *E. g.*, the weakest contact sensation is not necessarily the ticklish one; even with the utmost care and uniformity in the setting down of the stimulus-hair, tickle is not invariably associated with the weakest stimulation, and contact may appear below tickle in the graded intensity series. Further, the tickle judgment seems as much dependent on the sharpness and uneasiness of the immediate contents as upon the reflex shudder, desire to rub or other response which it excites; the tickle judgment is frequently definite when the tendency to such response is practically nil.

The second type of tickle, which perhaps differs from the first only in the matter of intensity and the amount of diffusion of the stimulation, is obtained most characteristically from the lips or the palms of the hands, and is described as quick, sharp, lively, and akin to pain, thrill-like or vibratory, tolerably well localized, with considerable irradiation and after-image. It also is sensed without delay, and the tendency to rub it away, which sometimes appears, seems to be associated mainly with the itching after-image which succeeds.

The tickle accompanying or following a moving stimulus resembles this second type, and is practically the same for the palm and for a hairy surface. It is variously described as phantom-like, feathery, diffuse, of a wavy, pulsating character;

after further practice in observation it is characterized as sharp, bright, intermittent, irradiating, almost tingling, suggestive of a weak, intermittent current, and is localized on the skin or just below it. The possible relationship of tickle to pain is indicated in the faint suggestion of soreness accompanying a swiftly moving stimulus, especially after one or two repetitions, and further in the unpleasant sharpness or liveliness which such a tickle shows on an inflamed or tingling surface, where all gradations from tickle into a closely similar but stinging or "nettly" train of sensations may be obtained. It is possible that this semi-painful character is largely due to reflexly excited after-sensations, into which tickle often indistinguishably merges as it approaches itch; in part, however, it seems a function of the "sharpness" of the immediate tactual contents.

In this tickle of the moving stimulus a second wave of sensation often follows at a just noticeable interval. This after-train may be either a wake of sharp popping points, or a cloudy blur, and is frequently fused either with a faint elusive glow, or with successive waves of cold and warmth. It bears a close resemblance to the gooseflesh shiver, dies away into a dull, superficial tension,[1] and suggests the possibility of a vasomotor reflex affecting either tactual or circulatory endings. This secondary wave is sometimes less, sometimes more ticklish than the primary sensation, grading in some cases into itch. With repetition the tickle of the moving stimulus is at first enhanced (possibly in the after-effect mainly), later greatly dulled, becoming mere contact or pressure, steadier, and indifferent in tone. The brightness of the contact quality suffers at the same time, however; only deep pressure remains unimpaired.

In summary, the observers agree that the peculiarity of the tickle experience is not exhausted by reference to the reflex disturbance excited by it, but resides somehow in its immediate sensory contents. The characteristics common to all forms of tickle are brightness or vividness, inconstancy or unsteadiness (which may be a matter of fluctuations of intensity, or of intermittent, scattering, or successive response of different points), and an ill-defined reference to the epidermis.[2] It is also certain that the weakness of intensity usually predicated of tickle is a matter of stimulus interpretation rather than a direct sensation estimate. The intensity of a light ticklish touch can hardly be equated, psychologically speaking, with anything short of pain, certainly not with the dullish pressure sensations aroused by a considerably heavier pressure on the same area.

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[1] *Cf.* Section A.

[2] The presence of temperature sensations is apparently non-essential.

The question whether the brightness or sharpness of tickle is to be regarded as a matter of genuine qualitative tinge, of clear-cut temporal or spatial definition, or as a function of attention, conditioned by the intermittence or flickering common to tickle, has been previously touched upon (in Section A). While there seems to be no sufficient reason for distinguishing tickle from contact or surface pressure as a unique quality, the peculiar vividness of the tickle quality remains somewhat perplexing. There seems some ground for identifying this vividness with clearness or the effectiveness of attention. Certain it is that tickle possesses a strong intrinsic claim upon the attention. Nevertheless, the suggestion that the brightness of tickle is merely a matter of exaggerated clearness and definition in attention, and that any lively intermittent tactual sensation would be ticklish, is unsupported by the facts. Intermittent stimulation with the electric current, tuning fork and the like may or may not be ticklish. Observation goes to show that a medium intensity and a medium amount of analysis are optimal; above and below these points we have either a blur, a complex of sharp points, or dull pressure. Whenever the vivacity of the tickle response is dulled by rubbing, fatigue, or the use of weak intensities, when (with electric stimulation) the individual points of sensation are too weak or too rapid for analysis, and when they are too intensive for integration and each in turn stands out in attention, the sense of tickling vanishes. Further observations bearing on this point are as follows. Tickle is most ticklish when just out of the focus of attention, or rather when the whole mass of sensation rather than any one point of it is the object of attention. The quick, tremulous, ticklish contact-sensation from punctiform stimulation of the palm becomes, with a slightly different setting or focussing of the attention, mere indifferent contact. Again, in a long observation period the observer may lose the tickle judgment entirely, apparently as the result of increasing skill and practice in analysis and objective reference.[1]

With regard to the relation of tickle and itch, the observers generally agree in distinguishing the latter as more persistent, painful and intolerable. Its fluctuations in intensity are also more marked.

2. *Distribution of tickle points with reference to the end-organs of pressure.* With punctiform stimulus, the palm alone seems to yield tickle from any point of its surface. Areas on the back of the hand or arm give tickle only in the immediate vicinity

[1] This disappearance might of course be traced to the wearing-off of reflex excitability, but for reasons which will be clearer later we believe that this is not the whole explanation of the matter.

of hair bulbs. In the intermediate spaces, contact or nothing is felt with the same stimulation. When the hairs are closely shaved, some observers hesitate to give the judgment of tickle except when the stump of the hair itself is touched.

The relation of tickle and pressure points is hardly ambiguous. Tickle may be obtained from any pressure spot if trial is made of different stimulus intensities; from the intermediate pain points very doubtfully even with intermittent stimulation.[1] Further, the points of maximal sensitivity for tickle and pressure agree fairly well, in view of the fact that the position of neither seems to be absolutely fixed,—sensitivity being confined to a minute semi-circle rather than to a point, and shifting with partial fatigue. Alrutz' observations to the contrary, as has been already pointed out, are probably due to the adoption of itch or secondary pain phenomena as the standard of tickle.

3. Regional sensitivity. While there are wide variations in vividness, and in the certainty with which the judgment of tickle is rendered, most areas yield tickle with either punctiform or moving stimulation. No absolutely insensitive area, so far as we have investigated, exists, with the exception of certain highly specialized surfaces such as the cornea. Both the tongue and the finger-tips, usually listed as non-ticklish, are found distractingly so if tested with a stimulus of the right intensity, moving or vibratory. What has been called insensitivity seems to be merely a matter of fewness of hairs, infrequency of end-organs, thickness of skin, or position of limen.

With a moving stimulus the following areas gave ordinarily the most vivid tickle: the roof of the mouth; the folds of the skin behind the ears, below the eyes, and between the fingers; the inside of the arm (which was increasingly sensitive toward the wrist); the palm of the hand; and the lips. These surfaces, it may be observed, are characterized either by abundance of fine hairs, or thinness of skin, or the presence of corrugations which may further irregularity and intermittence of sensation. For punctiform stimulation the favorable areas were fewer,—the lips, lower eyelids, cheeks, palm, and outer edge of the forearm giving the surest tickle. These areas apparently have only one feature in common, their richness in Meissner corpuscles or the thickness with which the hairs are set (especially in the case of the cheeks). In general, capillary dilatation seems slightly to increase sensitivity; whatever reduces the elasticity or tension of the skin, as oiling, seems to decrease it.

[1] The possible participation of these intermediate points of sensitivity in the tickle of a moving stimulus is another matter.

(*e*) *Conclusions as to the Histological Substrate of Tickle.*

1. Summary of peculiarities. No good reason is forthcoming for divorcing tickle from the sense of touch or superficial pressure. The practical identity of the points of maximal sensitivity of the two, the appearance of tickle without delay in an enormous number of cases, and the parallel effects of fatigue or over-stimulation on tickle and contact, furnish direct evidence of their close relationship. Indirect evidence of equal weight is furnished by the introspective verification of the qualitative similarity of the two sensations, based upon our analysis and study of granular pressure in Section A.

Tickle is characterized by its intangibility and absence of clear objective reference. The explanation of this peculiarity must be sought elsewhere than in its nearness to the limen, and its consequent qualitative indefiniteness and inability to call up assimilatory ideas. Tickle is not invariably correlated with the feeblest tactual impression; the latter is often sensed as contact, while tickle appears only at a higher point in the intensity scale. Further factors to be accounted for in any theory are the vividness, unsteadiness, and apparent diffusiveness or irradiating character of the simplest punctiform tickle.

2. Hypothetical. The inconstant wavering character of moving tickle, and the sense of motion which accompanies even the weakest tickle arising from punctiform stimulation, suggest that the uniqueness of tickle lies less in any qualitative peculiarity than in the irregular temporal course of the sensation, and its consequent grip upon the attention. The physiological conditions of this intermittence or unsteadiness must then be sought. In the case of the tickle attending a moving stimulus, the swift appearance and disappearance of successive points of sensation, combined on hairy areas with the effect of the vibratory response of the elastic hairs, may account fairly well for the phenomenon. Again, in the case of the ticklish halo surrounding a core of contact or coming out after the removal of the stimulus, explanation may have recourse to the irregular response or ringing off of different endings. The spread of stimulation to adjacent end-organs is especially possible with a light quick stimulus, which may form the starting point of a series of tiny ripples.

The query concerning the minute tickle, unattended by contact, which proceeds from punctiform stimulation of the skin, must next be answered. Does this also involve the response of more than one nerve-ending or nerve organ? In the case of the palm, where the tactile corpuscles are thickly set, it is doubtful whether with the utmost caution and the use of the finest point the isolated stimulation of a pressure organ is pos-

sible; multiple response may account, in part at least, for the vivid tickle which results. The tickle following punctiform stimulation of a hair-bulb on the arm, when the skin has been oiled and softened to prevent the transmission of the stimulation to the adjacent endings, obviously represents a case for which some other explanatory factor must be sought.

Either the actual physical vibration of the tissues, or some as yet unexplained oscillatory condition within the end-organ itself, or an intermittent internal stimulation attending direct or reflexly excited alterations of the pressure conditions within the capillaries of the skin, would here serve the purposes of explanation. It is worthy of note, in this connection, that an intrinsically oscillatory character was attributed by Meissner to his "contact" sense, and later claimed by von Frey for the sense of pressure. Goldscheider's similar view (propounded in his earlier monograph) we have already noted: intermittence is a normal function of the conditions within the end-organ, especially with light stimulation; a faint stimulus produces a whole series of excitations or vibrations, which are either damped off or transformed to an uniform steady displacement when a heavier continuous pressure is substituted for a light touch. The fact, however, that tickle is not invariably the outcome of the weakest touch stimulation, that for any pressure organ the adequate tickle stimulus is sometimes liminal, sometimes decidedly supraliminal, shows the need of a more careful examination of the conditions.

Our study of the granular pressure sensation furnishes us with a certain cue. If a more or less intensive stimulation of a single pressure organ may give rise to a pressure sensation not in itself quite simple, it is highly probable that the tickle produced by a slight disturbance of the same end-organ will be also in a fashion complex. Indeed, our conclusion was that both tickle and the sensory response to a weak intermittent current represent disintegrations of the 'granular pressure sensation,' which only render its compound structure more obvious. Accepting the Meissner corpuscles and the hair follicles as the end-organs of touch (and of tickle), we have in the number of endings furnished to a single organ and the possibility of their successive or asynchronous excitation an immediate histological basis for irregularity or unsteadiness of sensation. Further, the fact that the irregularity of response from these endings, which is sensed as tickle, is the customary but not the invariable result of light stimulation is readily intelligible. The stimulus may be insufficient (in area or intensity) to produce the general disturbance of the endings which gives rise to tickle; the fluctuations may be below the flicker limen. Or, when a penetrating or sharply pointed stimulus is applied above a hair

follicle, it is conceivable that one or more endings only are affected directly, and that little commotion is produced in the organ as a whole; the resulting sensation would then be identified as contact.

This asynchronous response may also be made to account for the apparent irradiation or diffusion of a simple tickle sensation (apart from the cases of actual gooseflesh response). The unsteadiness of the tickle of punctiform stimulation is easily confused with the intermittence of sensation which is ordinarily associated with the movement of an object along the surface of the skin. Since an intermittent stationary stimulus is rare in experience, and the difference in local sign for minute distances is slight, an interpretation in terms of movement frequently follows tickle, and an illusory judgment of irradiation or diffusion is given.

The origin of the tickle after-image, which is sometimes a mere breath-like phantom, sometimes vivid and bordering on itch, remains to be considered. With the exception of the possible addition of a painful factor in itch, it is in all ways similar to the primary tactual tickle just described. Whether it is to be traced to circulatory endings, to indirect excitation of the end-organ of touch through reflexly aroused vaso- or pilo-motor changes, or to mere inertia of the original tickle sensation, must remain a matter for speculation.

Although the above suggestions as to the mechanism by which a simple touch may be given an oscillatory character are impossible of verification, the fact that intermittence or irregularity, however produced, is an essential in tickle finds sufficient evidence in our introspections. The significance of this factor in the explanation of the tickle consciousness as a whole is further apparent in the supplementary introspections on ticklishness and tickling which follow.

(*f*) *Supplementary Introspections*

Deep-seated tickle. The following casual observations on deep-seated tickle go to show that here also a just perceptible unsteadiness or intermittence is the important feature. If a light swift friction of the surface of the arm is repeated until the bright superficial tickle has worn off, a deeper, dullish, unsteady and uncomfortable feeling succeeds, accompanied by an almost irresistible impulse to shudder or draw away. If a ridged surface, such as the finger-tip or the sole of the foot, is similarly treated, the effect is even more striking. The deeper tickle produced by heavy chest massage is similar, of an uncanny and uneasy character, and seems to represent not a solid mass of sensation but a loosely woven tissue in which the individual elements are barely distinguishable. In general, the

deeper tickle is dull as compared with the more superficial; at the same time it contains a certain element of soreness or sharpness. This deeper tickle is closely similar to the vaguely ticklish after-image which sometimes follows the heavy or continued stimulation of a single hair-bulb. The latter sensation is dull and of a vague uncertain character, due apparently to the unsteadiness which is a common feature of all tickle.

The peculiar liveliness of the reflexes excited by deep-seated tickle is probably due, not only to the customary exaggeration of dynamogenic values by discontinuous stimulation, but also to the greater number of nerve endings affected by massive kneading or rubbing. The discontinuity or unsteadiness is rendered more obvious by successive intensifications of the sensation when the stimulus passes over the ribs or the ridges on the soles of the feet or the palms of the hands.

Affective Reaction and Reflexes. The pleasantness and unpleasantness of tickle seem to be less a function of its immediate sensory aspect than of the muscle response which it excites and the suggestions aroused by the stimulus, and are largely dependent on the mental or nervous state of the individual. The pleasantness of the tickle in the ribs may be, in part at least, merely a suggestion from the smiling set of the facial muscles reflexly excited along with the more general muscle contractions; the pleasantness of a more superficial tickle is probably due to its light touch component and the soothing organic response and general relaxation conditioned by it. The unpleasantness of deep-seated tickle can usually be traced to the violent contraction of the diaphragm and adjacent muscles and the accompanying compression of the internal organs. The unpleasantness of cutaneous tickle is probably due partly to the sharpness of the sensations, which are almost akin to pain, largely to the vague, uneasy suggestion of the unknown, which gives an uncanny tinge to tickle as to the gooseflesh shiver. On the whole, the subjective moment in the immediate sensation of tickle is best described neither as pleasantness nor as unpleasantness, but as excitement. The significance of this statement we shall examine later.

(*g*) *Final definition of tickle.* We have cited already various facts which indicate that the definition of tickle is not complete when its constituent elements have been described and classified and their intermittence emphasized. Tickle is something more than a complex of intermittent or oscillatory sensations. The fact that intermittent stimulation with tuning fork, interrupted current, or moving touch is not always ticklish indicates that tickle is a function of certain rates and intensities only. Too slow a rate and too high an intensity are alike unfavorable, and apparently for the same reason; they

facilitate analysis, and the complex tends to fall apart into individual points, each capable of definite localization and objective reference. Further, the sense of tickle comes out most strongly when the initiatory sensations are, so to speak, just in indirect vision, and the attention is dispersed over the immediate sense-contents and the general bodily reaction. When a single sensory component or an assimilatory idea gets the focus of attention, and consciousness becomes analytical or critical, the tickle judgment vanishes. While the sense of tickle is heightened by the direction of the attention away from the idea of the stimulus to the sense-contents, the judgment of tickle is instable, often disappearing at a certain stage of practice in the analysis of this contents. Tickle is then replaced by the perception of contact.

This instability of the tickle judgment indicates that tickle is better defined as a complex of intermittent sensations *at a certain point of fusion or amalgamation*. The favorable conditions are those in which the tendencies to analysis and amalgamation are equally balanced, and we have neither a disconnected series of sensations nor a smooth union. Below the point of adequate fusion, which is dependent upon the rapidity and intensity of the component sensations and on the direction and skillfulness of the attention, we have disconnected sensations, either indifferent or verging on the painful, and capable of individual projection; above it we have complete fusion or steadiness, interpreted as contact and given objective reference, *i. e.*, a perception. —— This conclusion finds corroboration in the following introspective data. The two criteria, aside from the affective tone and tendency to reflex withdrawal, by which the observer finally came to distinguish between tickle and the weakest contact, were as follows: (*a*) lack of steadiness, smoothness, unity, and definite punctiform localization; and (*b*) absence of reference to a stimulus, and of visualization of a definite surface, or of the descent of the stimulus.

The significance of the structural pattern above assigned to tickle becomes fully apparent only when the tickle consciousness is examined as a whole, in relation to experience in general and in comparison with other typical complexes, perception in particular. In so examining it we come first upon certain characteristics to which so far we have done scant justice, its vividness, its characteristic feeling-tone, and its power to excite a general muscular reaction. The latter feature, which has given rise to so much speculation is, no doubt, in part to be explained by reference to a familiar physiological fact, the greater effectiveness of intermittent stimulation in exciting reflex centres to action. Further, this motor reaction is, to a certain extent, self-propagating, since certain of the sensations

to which it gives rise, especially those arising from the goose-flesh shiver, and the activity of the plain muscle fibres in the skin, supplement the tickle sensations proper and prolong the motive to general muscular reaction. The reinforcement which the motor reaction thus lends to the tickle sensations proper is probably part of the secret of the hold which tickle has upon the attention. Physiologically and psychologically, perhaps, we might say that the motor accompaniment of tickle and the hold of the latter upon the attention are both functions of the unsteady, fluctuating character of its components; biologically, they may be interpreted as expressions of the significance of movement in the earlier phases of the racial history. The motor reaction in general may be regarded as representing a survival either of specific reflexes associated with the primitive protective functions of the once all-important sense of contact, or of a primitive type of neural mechanism in general, in which excitations were guided directly into channels of motor discharge rather than of perceptual functioning.

This motor reaction may, however, be further interpreted as standing in a certain fixed relation of dependence to the peculiar structural pattern and degree of amalgamation of the contents which is known as tickle. This is indicated in the facts above cited, that the motor and organic reaction disappears, along with the observer's sense of tickle, when consciousness becomes critical, analytic and perceptual. This circumstance, which might be set up as an evidence of the dependence of the sense of tickle on motor reaction, we should interpret as follows. So long as attention is incompetent to cope with the semi-amalgamated series of impressions which constitutes tickle, this contents functions as a whole, the primitive sensorimotor path of least resistance is followed, and we get the reflex shudder and incipient innervation of the appropriate muscles of withdrawal or laughter, effective in proportion to the cumulative force of the stimuli and the motor excitability of the individual. When, however, analysis of the contents into its individual components is effected, the energy otherwise overflowing directly into motor channels is expended in the excitation of the sensory or ideational centres, and the assimilatory ideas and images, visual, verbal or motor, push the immediate sense-contents out of the centre of consciousness, the muscular reaction is largely effaced, and the 'perception' of certain definite sensations of contact succeeds the 'feeling' of tickle. Tickle is tickle only so long as it can monopolize the field of attention, in the form of an unsteady mass of sensation with which analysis is unable fully to cope.

'Feeling,' in the sense in which it is here employed, denotes, of course, neither an ultimate affective element, nor the un-

analyzable and unlocalizable, in the usage of Kroner, Lagerborg and others. As here used it refers merely to that peculiar type of consciousness which, in terms of function and cognition, represents not so much the abstract physiological properties of the process experienced as its physiological effect on the organism as a whole. In structural terms, it is simply that mass of ill-localized, ill-analyzed sensation which, because of its cohesion and its persistence, exercises an intrinsic claim upon the attention, and is distinguished by its peculiar vividness and its strong dynamogenic value. Tickle, as we have already said, while never actually indifferent, is best described neither as pleasant nor as unpleasant, but as exciting. In so speaking we have no reference to a third affective element; the tickle experience is, in fact, not so much exciting as it is itself (a certain form of) the 'feeling' of excitement.

It is in this connection especially that the true relation of tickle to organic sensation becomes apparent. The classification of tickle with the *Gemeinempfindungen* by Weber, Wundt and others has already been noted. While we have decided against the strictly organic character of tickle, its status as 'feeling' at once allies it to the internal sensations, since these customarily enter into feeling-combinations rather than into objective perceptions. From such organic complexes as hunger, disgust, excitement, and the like, tickle differs mainly in its greater accessibility to analysis, and hence in its greater tendency to disintegration.

While the basis of our classification of tickle with the bodily feelings is not precisely that of the older writers, the difference lies mainly in greater explicitness and in the attempt to formulate the difference in more distinctively psychological terms. The old division of experience into the objective and subjective was philosophical and schematic rather than psychological. In Weber's terminology, the use of the terms unprojected and projected sensation is strongly suggestive of the distinction between mere sensation and intuition or concept in the system of Kant. The peculiarity of the latter is not a matter simply of the addition of centrally excited ideas, assimilative or associative, but rather of some mysterious transformation which the contents undergoes at the hands of the understanding. The fact that in perception sensations are referred to the external world, in feeling to oneself, contains in itself no *a priori* reason why they should be differently sensed. Again, Wundt's reference to the external or internal character of the stimulus, and the lack of exact correlation between the course of stimulus and sensation when the stimulus is internal, expresses only very remotely the actual basis of the differentiation of contents. The internal origin of a sensation is undoubtedly a drawback

to its clear perception, mainly on account of the limited opportunity it offers for the simultaneous experiencing of the same physical fact through the medium of other senses, and the consequent failure to set up associations which might serve as an aid both in analyzing it out from other contents and in orientating it as a perception in consciousness. Tickle, however, fails of analysis and projection not from the lack of external associations at its command, but because of a lack of unity, and a baffling swiftness and irregularity with which the processes of perception cannot keep pace. In addition, the kinæsthetic or organic sensations to which it gives rise tend to assimilate it to themselves, and thus weaken the motive to analysis and bind it the more firmly to the subjective.

The lack of objective reference is, then, rather an effect than a condition of the peculiar character of tickle as a 'feeling;' a condition merely in so far as it means the non-appearance of certain centrally excited sensations which would help to break down the tickle complex; an effect, in that the temporal, spatial, and intensive irregularities which constitute tickle a semicohesion of shifting sensations, with the status and magnified motor value of a 'feeling', are precisely the factors which stand in the way of its objective reference or projection.

Tickle may thus be finally defined as an intensely vivid complex of unsteady, ill-localized and ill-analyzed sensation, with attention distributed over the immediate sensory contents and the concomitant sensations reflexly evoked. Its immediate sensory contents is not qualitatively different from contact, but in actual experience tickle is distinguishable from the ordinary contact complex in its character of a 'feeling' rather than a perception.

A NEGLECTED MEASURE OF FATIGUE

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Von Kries (1) seems to have been the first to have recognized the psychological implications of the maximum rate of repeated voluntary movements. His experiments were made by attaching an electric wire to the end of the fingers, which closed a contact when the finger tapped upon a metal plate. The experiments were not especially systematic, and maximum rate only appears to have been taken into account. We find, however, a distinct recognition of the neural character of the limit placed upon this maximum rate, and of its relationship to that of the incomplete tetanus in sustained muscular contractions, as also observed by von Kries, previously by Horsley and Schaefer (2), and by Schaefer, Canney and Tunstall (3). Two years later Griffiths (4) repeated and elaborated these experiments, with especial reference to tetanus of the loaded muscle. "There is a gradual increase in the number of muscular responses per second as the weight is increased up to a certain number; any increase in the stretching weight beyond this point is accompanied by a decrease in the number of muscular responses per second." His most important observation for us, however, was that this rate in tetanic contraction usually increases slowly until about the end of the first minute, and then decreases slowly. The fatigue phenomena, however, are very slight for the longest period observed, 2½ minutes. It is necessary to bear in mind this result for tetanic contraction for comparison with the much more marked fatigue phenomena obtained when, instead of sustained contractions we are observing repeated voluntary movements. The observed relationships between these rhythmic discharges in tonic contractions and the most rapid repeated voluntary movements, as well as clonic contractions and tremors, I hope to discuss subsequently in a separate paper. For the present we may confine ourselves to the most rapid repeated voluntary movements, which have since had considerable experimental development under the name of the "tapping test."

Although the first psychological observation is the work of von Kries, the later development of the test has gone on almost wholly outside of Germany. It is practically unknown to the

Psychologische Arbeiten, that home of generalized researches, especially with reference to continued work. In 1891 Dresslar (5) took up the matter independently, publishing the results of an extensive series of experiments upon himself, as well as minor observations on other subjects. A mechanical form of counter was used, the time being taken for 300 taps. The principle of the instrument, while giving no account of the individual taps, might register gross fluctuations in rate. The results, however, speak very poorly for its trustworthiness in this respect. It seems to have given no indication of the extent of fatigue or appreciation of its significance. Only the slightest evidence of "incipient" fatigue was noted, whereas later investigators have repeatedly found the fatigue losses to be very marked even within the first 100 or 200 taps. The subject worked at the limit of practice, and it is interesting to note that "it was thought that after practice this number (300) would not be fatiguing," whereas actual observation shows that fatigue loss may be even greater at the limit of practice than at its beginning. All sensations of fatigue, Dresslar notes, had ceased with the first few days of the work. This is in accord with the writer's observations; the sensations of fatigue disappear with continued practice, but the objective phase persists. The average rate at the limit of practice for 300 taps was 8.5 per second, which is abnormally high. The work was done with the right hand; a few experiments with the left hand gave an average rate of 5.3 per second. This places the right and left hands very much further apart than they appear in the studies of Bryan, Marsh, or the writer. It can hardly be taken as other than an indication that the practice of one member in this function does not essentially affect the performance of the other members; so far as I know it is the most important single datum that we have on this point. The rate was found to be decreased by physical, and rather increased by mental work; some unsystematic observations of the writer are in accord with this result. How much confidence can be placed in the daily rhythm records it is difficult to say, because a performance in the tapping test at the limit of practice exerts a "warming up" influence that extends over a considerable period. However, the writer's experience would entirely confirm Dresslar in saying that lack of practice would account for the failure of such rhythms to develop in his two other subjects. The analysis of the practice of these subjects, however, is almost certainly at fault, for practice improvement is by no means eliminated on the third day, and, as has been said, gives little or no immunity to fatigue losses.

Presumably because of its relative simplicity as well as its high statistical reliability, we next find the test pitched upon

as a measure of "voluntary motor ability" in two investigations of mainly educational bearing. The first of these is the well known research of Bryan (6). The apparatus here used is a form of mechanical counter, registering the number of taps made during a standard interval of time, uniformly five seconds. While the method can of course give only a very incomplete idea of the actual fatigue phenomena, it seems to have demonstrated them far more reliably than the instrument used by Dresslar. A lowering of the rate was observed after 10 or 15 seconds work; it actually begins somewhat sooner, but the method would hardly detect it. We have no precise data as to what happens after the first minute or less; Bryan seems to have found that this decrease goes on at a uniform rate for about 10 minutes, when it becomes slower but continues until a zero is reached after some hours. He notes the question of partial recovery from ordinary fatigue: in the writer's experiment it may be taken as absolute in less than three minutes of rest from thirty seconds tapping. The main body of the work, however, is concerned with the increase in gross rate as related to age,[1] and beside having nothing directly to do with fatigue phenomena, is too familiar to need recapitulation here; the main objection to it is that it hardly recognizes sufficiently the effects of either practice or warming up.

In the work of Gilbert (7) we have the first definite use of the test as a fatigue measure. The subject executed taps on a telegraph key for 45 seconds, the first and last five seconds being recorded. As a fatigue measure, Gilbert gives the per cent. of loss in rapidity during the last five as compared to the first five seconds. The susceptibility to fatigue as indicated in this measure decreases uniformly for both sexes with increase in age, the extremes for each sex being about 21% at six years and 14% at seventeen years. It is noteworthy that the boys show throughout a greater percentage of fatigue loss than the girls, though their initial superiority is sufficient to leave the balance still in their favor. Havelock Ellis has cited this result as an example of the "more continuous character of woman's activity," but there would seem to be a possibility that in the class of subjects used a motor measure of this sort would interest the boys more than the girls, and they would consequently try harder, and tire quicker.[2] In this connection it may be observed that the adult men used as subjects by the writer show on the whole about as much fatigue loss during

[1] See also, with reference to the speed of the different joints, Woodworth, The Accuracy of Voluntary Movement, Mon. Supp. 3, pp. 108-10.

[2] See, however, the results of Bolton, quoted below.

30 seconds as Gilbert's children did during 45, which may argue for inferior co-operation in the children as a group.

Gilbert (8) also reports a subsequent similar series of experiments, made upon school children in Iowa, the first having dealt with Connecticut children. A mechanical counter was used. The general results are similar, though there are some special differences of interest. As to the number of taps in 5 seconds, the Iowa boys begin at 22.1 at 6 and do 34.4 at 17, while the Connecticut boys do 21.0 and 35.0 at these ages. For the girls the figures are 22.3 and 33.8, 19.7 and 31.5 respectively. During the earlier years the Iowa girls are slightly superior, while the Connecticut girls were always inferior to the boys. An interesting aspect of the results is found in the classifying of the children by their teachers into 3 groups, bright, average, and dull. In gross rate, the bright subjects are about equal to the average subjects, the dull subjects somewhat inferior. As regards fatigue phenomena, the girls again uniformly lose less than the boys, though the difference is practically nil during the last five years, 15-19. As regards the differences in the rating of the children, the results are rather striking. The bright children lose more than either of the others at 6, and less than either of the others at 19; this progressive immunity to fatigue is rather less marked in the average, and least of all in the dull children.

The tapping test also figures among the experiments made by Gilbert and Patrick (9) upon three individuals every 6 hours during a 90 hour sleep-fast. The graphic method was used, the subject tapping for 60 seconds; only the first and last five seconds, however, were counted. No account is taken of practice, which probably obscures most the results somewhat. The rates show little progressive change, but vary more than ought to be expected. The per cent. of loss by fatigue is irregular in the second subject, rather decreases in the first, and increases in the third. It should be noted that the scores of the tapping performances of the first subject are more regular than those of the other two and they may be more trustworthy, since he had probably had more practice with the test. The time of isolated individual taps has also been measured by Seashore (10), and compared with simple reaction time to various types of stimulation.

Contemporaneously with the first work of Gilbert, and also in the same laboratory, Bliss (11) introduced a great improvement in the method, though it involves complications which would render it unavailable save in laboratory practice. Bliss directed attention mainly to the variability of the individual taps, which he seems to be the first to have studied. The method was, of course, graphic, the time intervals being regis-

tered by a magnet in circuit with a 100 v. d. fork. The taps were recorded by the passing of a high tension spark from the tip of the recording point to the drum. It is unfortunate that with such an improved method available more experiments were not performed; the records, each of 180 taps, are only six in number, and all but one are on the same individual. The averages of the records show unmistakable fatigue losses, though I am inclined to think the fluctuations in rate are greater than would ordinarily be found; *i. e.*, the decrease in rate would be more regular. Bliss also speaks of a decided warming up in the rate of the individual taps during the first second; this also appeared in the subsequent experiments of Moore, and while the method used by the writer does not lend itself to very accurate determinations on this point, this initial warming up appears also to be generally present in his experiments. Fatigue losses begin roughly after about five seconds. His essential point, that the variability of the taps decreases as fatigue establishes itself, the results seem to indicate with some assurance.

Moore (12) subsequently used the same method of recording as Bliss, but so modified the method of making the taps that his results are not strictly comparable with those of the other investigators. The movement was confined to the index finger which shifted a slide 5 mm. forward and back as rapidly as possible. So far as the initial warming up in rate is concerned they agree with Bliss, but fatigue, which again appears remarkably late, seems to increase the variability of the taps. The gross rate is relatively low. These series were each about 480 taps long, which the investigator considers very near the point of complete exhaustion. When it is remembered that the freehand tap can be continued at maximum rate for an hour or more, it is quite apparent that the fatigue phenomena of these results are in no way comparable to those obtained by the previous investigators.

In studying practice-transference in this function, Davis (13) reverts to the tap upon a telegraph key, recording the number of taps per five seconds upon a mechanical counter. The results are very peculiar. The gross rates are exceedingly slow; the slowest individual among some thirty normal and pathological subjects tested by the writer would come at almost the average of Davis's subjects. The right toe was the member practiced, as it was endeavored to determine the influence of this practice upon the hands and left foot. The member practiced did not always improve, nor when it did was its improvement always greater than that of the unpracticed members. Upon one subject is recorded an experiment of 900 taps without fatigue loss. Altogether the findings are so out of key with practically the entire remaining literature of the method that it is very difficult to judge of their relation to it.

Binet and Courtier (14), and, more recently, Raif (15), have called attention to the relation which the tapping test bears to facility in playing the piano. The former investigators used the graphic method with air transmissions, giving some idea of the force of the taps. Rates of 6 to 10 per second were obtained for single fingers, the difference between those practiced and unpracticed on the piano being not so much in the gross rate as in the regularity of the force employed. Raif also finds the educated steadier, rather than faster, than the novices, and seems to make an *a priori* assumption that the educated are faster than the ignorant.[1]

Binet and Vaschide (16) introduced a considerable modification, which might at first sight seem to be also a considerable improvement, into the method. They object to the telegraph or other key as affording too incomplete an analysis of the movements involved. Instead, a Mosso ergograph was modified into a sort of myograph, using a weight of 1 kg. to be lifted and released as rapidly as possible. This isolates the movement much as in Moore's experiment, and also greatly increases the muscular effort. But as von Kries has pointed out, the significance of the experiment is essentially dependent upon having as free a movement as possible, a condition which his own experiments, perhaps, realize as completely as any have done. Moreover, it must be noted that if we isolate small muscles like those of the finger, and especially if we weight them, we complicate the experiment with a second fatigue factor whose relation to the specific fatigue phenomena of the test it is very difficult to estimate. We fatigue the muscle with reference to the force of its movements as well as to their speed. Various considerations render it desirable that whatever joints we are testing for this function should have as nearly constant muscular power behind them as possible. These conditions are probably best obtained by allowing the subject to select his own preferred method of tapping, and simply to see that he maintains it throughout the experiment. Under ordinary conditions this usually amounts to a combined wrist and elbow tap, with the elbow rested upon the table. No one will dispute that under proper conditions the myograph is ultimately more precise and accurate than the key, but such an instrument would have to be of so delicate a construction as to be very inconvenient for ordinary experimental work, while its advantages as a measure of individual differences in the function would be largely factitious, as Binet and Vaschide themselves admit.

In spite of these essential differences in the isolation and

[1] *Cf.* also Davis's paper, p. 13.

loading of the muscles, their results are not very different from what one would expect from the previous researches. The tests were twenty-five seconds in length in 15 subjects, and the rates varied from 3 to 8 movements per second; from considerably below to rather above what is ordinarily obtained. The average rate at the beginning of the experiment is given as 5 per second, that at the end as 3.5 per second. There is thus a considerable fatigue loss in rate which the investigators state to be regular, though no precise measurements are indicated. Such analyses as are given indicate that the decrease is not regular, but, as natural, most marked at the beginning. The amount of loss is rather more than one would expect, owing presumably to the loading of the muscle, and shows more marked individual differences than are usually found; it is a question whether these do not as much represent differences in co-operation as in ability for the test itself.

A return to the simplicity of von Kries's procedure is found in the method used by Marsh (17). The subject tapped upon a metal plate with a stylus held in the hand, the taps being recorded by an electric counter similar in principle to the Ewald chronoscope used by Gilbert. The unit of the experiment was the time taken to make a specific number, usually 100 taps, as measured with the stop watch. A large number of experiments upon different groups of subjects gave average rates varying for the right hand between 6.7 and 7.5 taps per second, and for the left hand between 5.8 and 7.2 taps per second. These ranges are small because the averages do not represent records of individuals but of groups; the relation between the right and left hand is about the same as that obtained by the writer. It will be remembered that the afternoon records quite generally surpassed those taken in the morning. This investigator also performed an extensive series of experiments on himself, taking the time for 200 taps at different portions of the day. These results are in conformity with the above, but they do not maintain a very close correspondence with the daily rhythm curve of Dresslar; moreover, the later periods of the evening, when Dresslar did not work, are found to be the most rapid of all. No account is taken of fatigue phenomena, but so far as the gross rates are concerned, these experiments probably combine extensiveness and reliability in as good a ratio as any that we have.

There are three more or less general researches of educational bearing that have also made use of the test, among others. Bagley (18) employed a telegraph key and an electric counter, finding no special correlation between tapping rate and class standing. Bolton (19) employed a mechanical counter, in a series of experiments with much the same object, obtaining

rather contrary results. Two groups of children were selected, apparently mainly according to home environment, and submitted to various tests. The groups consisted of children of eight and nine years. Between the right and left hands no significant difference between good and poor was found, but in respect to gross rates, the good at nine differed more from the poor at nine than the good at eight did from the poor at eight. Also did the good at nine differ more from the good at eight than the poor at nine did from poor at eight. The statistics are not altogether satisfactory, but the differences would seem large enough to be significant. and to have the interpretation which Bolton suggests for them. It is also a very suggestive result that in successive trials the good children improved, while the poorer lost slightly; but the phenomenon is one to which I should prefer to apply the term "warming up" rather than practice, which I would reserve for gains of a more permanent character than these seem to be. As regards sex, the girls tap faster than the boys, in direct opposition to the first results of Gilbert. If this difference is significant it is also suggestive that the poor girls are more superior to the poor boys than the good girls are to the good boys.

Kelly (20) improved the evaluation of the test by having the subject tap for 60 seconds, taking the reading every ten seconds. A fairly precise fatigue curve can thus be obtained, but unfortunately the readings cannot be made accurately enough, at least with a subject who taps at all rapidly. This is at present the most objectionable feature of accurate work with the tapping test; the graphic method is necessary, and its evaluation very tedious. Nevertheless there can be but little doubt that should the test demonstrate sufficient special value as a fatigue measure, these difficulties could be obviated through special apparatus.

An interesting observation is reported by W. G. Smith (21), who used the graphic method and air transmission in comparing the rates of normal and epileptic individuals. There is probably no significant difference in the gross rates, whose average is about normal, but while the normal average was 6.3 per second for the first eight seconds and 5.9 for the second eight, in the epileptics it was 6.2 for the first eight and 6.3 for the second eight. The normal individuals fatigue, while at least some of the epileptics must have warmed up considerably during this period. This phenomenon is very rare in normal individuals, but has been observed with some regularity in certain psychoses; its interpretation is by no means clear.

To sum up, the maximum rate of repeated voluntary movements is a function that practically every investigator working with sufficiently accurate methods has found to be subject to

fatigue effects, though the degree of this subjection has differed considerably. Nothing is definitely known regarding the relation of fatigability to the gross rates; *i. e.*, whether faster individuals are likely to fatigue more than slower, nor is the significance of the gross rate itself well understood. Little if anything can be regarded as established in regard to the practice phenomena of the function either in respect to gross rate or susceptibility to fatigue. We have a rough knowledge of the limits within which the initial rates vary, *i. e.*, from about 5 to 14 per second according to the individual; it has not been brought out in what way this rate is correlated with other and deeper mental faculties in the individual, except in so far as is given in Gilbert's and in Bolton's figures. In spite of these considerations, the writer's experience with the test, amounting to some 1,500 individual fatigue curves upon upwards of 30 subjects under many varieties of conditions, seems to justify the belief that we have here an experiment that will in every way bear comparison with such fatigue tests as have found more general employment as measures of this function.

When we speak of a measure of fatigue we may mean either a measure of the state of fatigue or of the susceptibility to fatigue.[1] In measuring experimentally a state of fatigue we usually have certain objectively given or assumed fatigue conditions, and we attempt to determine what has been the effect of these conditions upon some function or functions subject to psychological measurement. Various forms of psychological tests have been used in this way. Griesbach made the suggestion, now rather gone by the board, of cutaneous sensibility; the *Kombinationsmethode* of Ebbinghaus is a form of the uncompleted word test; Ritter has proposed a form of our own familiar *A* test. There is little limit, other than the purely mechanical, to the experiments that can be applied in this way. But as has more than once been pointed out, there are great difficulties in the way of using the mere optimum performance in a given test as a measure of the state of fatigue. This optimum performance, especially in school work, is affected by entirely too many other conditions than those it is here used to measure. Even such elementary things as interest, distraction, and rivalry can have a considerable influence upon the gross performance, and are quite likely to vary independently of the fatigue process itself. The reader may remember the interesting observations of Schuyten (22), who experimented with auditory memory, testing the children morning and afternoon of the same day, and afternoon of the first day and

[1] Upon some of these points the writer has already touched, from a slightly different angle, in an article in the *American Journal of Insanity*, LXIV, pp. 502 ff.

morning of the next. Whether made in the morning or afternoon, the children did better in the first test than in the second. The only inference that is in any way justified by such an observation is that the factor of novelty was more potent than that of practice; but in motor accuracy the reverse condition might well have obtained.

Such experiments as these belong to the following type; an initial test a, is followed by a period of supposedly fatiguing work w, after which is made a second similar test a^1. The entire result is given in the difference between these two measures, a and a^1, and is absolutely dependent on their validity. The susceptibility to whatever condition is brought about by the work is given in the relation of the two quantities, but a^1 is not necessarily less than a; indeed, there are numerous instances from the literature in which the second test shows a marked gain over the first. And we must remember that the same relation between a and a^1 may be brought about by very different fatigue conditions. The measures a and a^1 have often been so unprecise, and the work done between them so ill-controlled as to give really no reliable criterion of susceptibility in the individual, and only a very slight one for the group.

But perhaps the greatest objection to be brought against this type of experiment is that it gives so little opportunity to distinguish between the individual who is already so fatigued as to suffer little fatigue loss during the experiment, and the individual who, though unfatigued, suffers as little through a relative immunity to fatigue. The only clue that it gives at all is in the gross scores, and, as has been said, the individual measures are so coarse as to make this criterion quite unreliable. The situation is complicated by the fact that the former class is likely to be made up largely of individuals highly susceptible to fatigue. But when we measure a fatigue in terms of itself, *i. e.*, study the actual fatigu phenomena of a certain function, there is reason to believe that we can differentiate these groups through factors largely independent of the gross scores.

And in this, I think theoretically justifiable, shifting of the viewpoint from the measurement of discrete states of fatigue to continuous determinations of susceptibility, the problem is otherwise considerably simplified. We largely eliminate the errors arising from the differences in attitude toward separate tests, because the measure consists of a single test. Of course, if the single test is a prolonged one, such errors are more likely to introduce themselves, but from the very fact of its being more extensive, they are less likely to lead to a false interpretation of the results. We are no longer attempting to measure the fatigue due to the continuous exercise of one function by its effect on discrete performances in another, a procedure

whose logic often suggests measuring the width of the mouth of the Amazon River by taking soundings in Chesapeake Bay; but we are using continuously a single function of determined efficiency of performance throughout. There would seem to be little room for comparison between the validity of the two procedures, always bearing in mind the question, is there such a thing as general susceptibility, and if so, to what extent may individual measures be expected to reflect it? In making such selections we are again in danger, to reverse Dr. Edes's expression, of inferring a rise of the Mississippi at the mouth from the occurrence of a thunderstorm somewhere in Minnesota. We are not yet, and perhaps never can be, fundamentally sure of how far it is justifiable to judge of a general fatigability through a determination restricted to a few narrow functions.[1] The most we can do is to select from the measures available for the study of fluctuations in continued work, such as shall best obviate the sources of error peculiar to this class of tests, as well as best meeting the more general requirements of psychological experiment.

There seems to be but little present reason for giving *a priori* preference to any special type of fatigue measures. Of course, if we were attempting to measure the fatigue of some special function we should naturally cast our test as nearly as possible into terms of that function; but using the term in a more general, or, if the word may be permitted, a more abstract sense, there is slight, if any, theoretical reason for preferring a motor test over a sensory, an intellectual over a motor. We must consider them upon their merits, as psychological tests. There is probably no test that entirely obviates any of the sources of error mentioned; but they are certainly subject to them in widely varying degrees, and differ widely in the precision with which they reflect ability in their special fields.

First of all, such a measure should make as few demands as possible on the conscious co-operativeness of the subject, because this introduces a large additional variable, absolutely uncontrollable, and of very ill-understood significance. The degree of co-operation accorded should be as constant as possible, and this end is probably best secured by making the degree demanded as small as possible. Kraepelin's addition test, which has figured so largely in the fatigue literature of the higher mental processes, has two considerable defects, and this is one of them. Each successive addition in Kraepelin's test requires conscious readjustments of no little complexity, and their in-

[1] We must also consider to what extent one's fatigability at high, experimental pressures of work may be correlated to that at ordinary, moderate pressures of work.

creasing irksomeness has been held in no small degree responsible for such fatigue phenomena as the workers with this test have observed. No doubt these readjustments tend to become automatic after a certain degree of practice is reached; but in ordinary fatigue experimentation we deal with individuals at practically the beginning of practice in such a test as this. In the earlier stages of practice consciousness cannot wander a hair's breadth from the work in hand without seriously affecting its amount, and these wanderings are equally difficult to prevent or control. In this respect it yields to the ergograph, though this instrument makes the frank assumption that "maximum" has the same meaning for consciousness at each pull. Moreover, the curves are considerably complicated with fatigue sensations; the weight instruments probably more so than the spring.

The feelings of annoyance arising from a long continued test make it desirable that the experiment should be one giving the requisite data in as short a time as possible. Here the Mosso instrument stands out best, and in the spring ergographs the characteristic phenomena also appear far sooner than in the tests of the higher mental processes, if indeed, as ordinarily observed, these tests show any objective fatigue phenomena at all. In this connection it is very interesting to note the method suggested by Squire (23), which consisted of the indefinite repetition of a rather complex motor act, recorded upon a kymograph. While the test was thus motor in character, the measure of fatigue was concerned with the higher mental processes, being given in an increase in the lapses and irregularities in the performance of the act. Considered from the utilitarian standpoint, the experiment requires a considerable time to make, and demands a degree of co-operation that would probably render it unavailable save among subjects of special training. A quantitative statement of the findings of such an experiment would be exceedingly difficult, in fact, none is attempted; and little practical value can be attached to a test that does not readily lend itself to this treatment. The study is most worthy of note as an attempt to analyze out experimentally a certain source of error, as that of muscular fatigue with the ergograph, and so to limit objectively the interpretation to be put upon the fatigue phenomena observed.

Thirdly, such a measure should be precise. This is the other weak point of the addition test. As at present given, we can measure the total amount of work done in a fixed interval, say 15, 30, or 60 seconds, or we can measure the time required to perform a certain number of additions, say 50. What goes on within these periods is absolutely hidden from us. We have no objective means of knowing whether a period of decreased

efficiency is the result of a gradual slowing down of the associative process, or through one or more extensive wanderings of the attention. Such elementary considerations cannot be arrived at unless the individual processes are recorded, and in the addition test this is impossible to do with any accuracy. Moreover, there remain the errors. As there is no way to deal with them, they are usually disregarded; but they are far from being shown to be negligible for the significance of the test.

Another factor must be mentioned, which is of vital importance where there is any question about the co-operation, as in clinical work. Unless the answers in the addition test are either spoken or written, there is absolutely no objective evidence as to whether the work has been done or not, save in so far as one might infer it from the figures of the results obtained. From these objections it will be seen that the ergograph is relatively free. The objective record of the work is there, and is not complicated with two such incommensurable factors as amount and error in the addition test. In precision, also, the ergograph record leaves little to be desired, though it must be remembered that this precision is not necessarily synonymous with accuracy, at least in the majority of the instruments. Nevertheless, so far as concerns the technical points of speed, objectivity and precision, there can be small doubt of a consistent superiority of the motor measures over the intellectual. Only in the simplicity of their apparatus have these latter an advantage, and this advantage is considerably discounted by the fact that it involves no corresponding simplicity of procedure for the subject.

It is worthy of note that so much attention has been given to the force of movement, to the relative exclusion of its other functions. It is difficult to imagine any *a priori* reason why the force of movement should have any special superiority as a psychological measure. Our primary aim is a measure of a neural process, and every one knows the extent of the discussion as to whether the ergograph is really a measure of nervous facts at all. On the contrary, we find in the maximum rate at which voluntary motor innervations succeed each other, a fatigue phenomenon so entirely foreign to what is observed unless nervous elements of some degree of organization are concerned, that there seems to be little, if any, escape from the conclusion that this phenomenon is at least mainly of nervous origin. Further, it is probable that on the purely technical side its experimental efficiency is at least equal to that of the ergograph. It is comparatively certain that it demands less co-operative effort; records of a considerable degree of trustworthiness have been obtained from depressed and demented subjects who would have been quite unamenable to ergographic

experiment. Sensations of fatigue at any stage of practice seem to influence the results to a minimum that is not approached in any other fatigue experiment with which the writer is familiar. Neither gross efficiency nor susceptibility to fatigue seem correlated to any significant degree with the subjective estimate of speed or with the sensations of fatigue that accompany the work. In the time required by the actual experiment, the test also makes a favorable showing; quite sufficiently characteristic fatigue phenomena normally appear during a period of 30 seconds, which interval has been selected as the standard in the writer's experiments. In using the simple tap, its ultimate precision is probably inferior to that of the ergograph, though it is quite equal to it so far as the actually evaluated factor, *i. e.*, the number of taps is concerned. Moreover, this objection could be entirely overcome by using a myographic instrument, as did Binet and Vaschide. There remains the tediousness of evaluation, in the counting of the individual taps; but it is probably better that the evaluation should be tedious than that it should be relatively unintelligible, as in the ergograph, or relatively meaningless, as in the addition test.

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LAURENS PERSEUS HICKOK

By JOHN BASCOM

Of all the men whom I have known Laurens P. Hickok was best fitted to command high and uniform respect. One might be drawn to him or remain relatively indifferent to him, but once within the circle of his influence one could not do otherwise than cherish for him warm esteem. He was not a man whose affections and passions nestled close together, or whose imagination, like a strong wind, bore him and others with him in new and unexpected directions; but his feelings and his thoughts were so vigorous, so perfectly interfused, so transparent in their scope, that they retained the attention they had once arrested. Sentiment was so dissolved in a fitting intellectual medium that one hardly thought of it, or felt it, separately.

This mastery was the more remarkable as he had occasion to present a system of theology which has made so much of authority, and which, although appealing to reason, has surrounded itself with so many narrow, personal and conventional motives. His own mind was satisfied with the inherent rationality of his beliefs, and on this ground he habitually presented and enforced them. He felt them to be perfectly open to inquiry, and that the reasons on which they rested were an essential part of them. He invited investigation as the fitting medium of conviction. He stood frankly and fearlessly on the basis of truth, feeling that only thus could that assurance be reached which comes to every mind in the successful use of its own powers; an assurance quite beyond any gloss of rhetoric or dexterity of logic. Personal motives weighed so little with him that he was hardly aware of their existence in others. That self-consciousness, that consciousness of surrounding circumstances and claims, which even good men with difficulty escape, left him unembarrassed; alone with the truth, his own thoughts and the thoughts of others concerning it. What he said was his personal conviction. No matter from what source it originally came, he was only interested in opening up to the minds of others this one royal and independent road. The air is air for us all, and native to every man's lungs.

I first met him in the fall of 1851, holding the chair of systematic theology in Auburn Theological Seminary, which at

that time commanded a good attendance. It was the most important position he ever held, and the one best fitted to his powers at the period of their full vigor. There is no weightier demand ever made on the mind and heart of a teacher than that made by young men, finishing a course of study by a consideration of the spiritual problems which determine the significance of life; problems which are to define our own action toward life and help us in our guidance of the actions of others. The student may have made many acquisitions, have entertained and passed through many inquiries, but these last questions, for the sake of which all other questions have been put, remain to receive a fitting answer, casting light before and behind till the day dawns upon the waiting spirit. It was in this temper of expectancy that my class was present, and however far off and ineffectual the conclusions reached may have been, they were sought after and waited for as cold water by a thirsty man.

Laurens Perseus Hickok was born in Bethel, Fairfield County, Connecticut, December 29, 1798. He was brought up on a farm and came into possession of a sturdy physical constitution which stood by him during a long life. He was graduated at Union College, studied theology and entered on his ministerial work in 1822. He first preached at Kent, a small township in Litchfield County, Conn. He was called thence to Litchfield to occupy the pulpit vacated by Doctor Lyman Beecher. In 1836 he was invited to take the professorship of theology at Western Reserve. Here he remained eight years, and then accepted the same professorship at Auburn Theological Seminary. This he also held for eight years. As a preacher he was simple, thoughtful, effective. Instruction was imparted and reflection called out by his discourses. In 1852 he became vice-president of Union College, with the understanding that he was shortly to become president. This expectation was not fully met. He remained at Union till 1868, and was not in complete charge till the last portion of the time. His earlier work was restricted by the presence of President Nott, an able but a very different style of man. Moreover the administrative duties of a college were not those which gave freest play to his powers, nor was the instruction of undergraduates equivalent to that of a seminary class. His presidency at Union, his alma mater, seemed to be the crowning feature of his life's labor, but was hardly so in fact. While it was successful it was less genial and rewardful than previous work. He resigned in 1868, and removed to Amherst, an educational centre and then the home of his nephews, Julius H. Seelye and L. Clark Seelye, who were professors at Amherst College. Here he spent most peacefully and happily his last

years, cherished in the affections of his many pupils. He died May 7, 1888.

Dr. Hickok's philosophical labors, for the sake of which this sketch is written, were very definite and closely interlocked. His first volume, Rational Psychology or the Subjective Idea and Objective Law of All Intelligence, was published by Derby, Miller & Company in 1849, Auburn. It contained the prominent conceptions of his later volumes. It gave rise incidentally to two manuals, Empirical Psychology and a System of Moral Science, used by himself at Union, and also by President Seelye at Amherst. In the line of an extended application of these principles of knowledge came, in 1858, Rational Cosmology, in 1872 Creator and Creation. In the same year appeared Humanity Immortal; Man Tried, Fallen and Redeemed, a psychological justification of his theological system. His work was closed with The Logic of Reason; True Logic must Strike Root in Reason, 1875. His later volumes were published by Lee & Shepard, Boston. Doctor Hickok did not depart materially from current orthodoxy, but he gave it interpretation and support by his rational conceptions of the nature of knowledge. He put his own mind at rest on what he felt to be the final statement of human powers. While, therefore, he might approach other systems of doctrine in a formal presentation, his own creed was offered as a universal solvent of ethical, spiritual relations. He urged it as rational, through and through,

His Rational Psychology took form in the mind of Doctor Hickok when the Transcendental Philosophy was in the process of development in America, a philosophy which seemed to him to combine fresh insight with wayward and vagrant thought, and to call for a new definition of the nature of knowledge. This he undertook to give in his Rational Psychology by a sufficient statement of the necessary conditions of knowledge, of perception, understanding and reason, all standing fast with and by means of each other. The foundations of truth, its ultimate validity, were to be disclosed and vindicated against all confusion and scepticism. He felt that the paths and methods of spiritual thought could be laid down with something of the same exactness and certainty with which the mathematician follows the clues of space relations. It was a fresh survey of the highways of knowledge on which he entered.

There was also in the air the dogmatic assertion of common-sense which went with the Scottish Philosophy; an assertion of certainty rising above analysis and resting on the accumulated convictions of men. It affirmed that knowledge as one whole stands or falls together, that we cannot break in upon it and trample it under foot without scattering it altogether.

This inherent conviction, which the school of Reid dogmatically affirmed, Doctor Hickok strove to bring out into the light of reason and to disclose the self sufficiency of knowledge as one whole. Though its several parts may suffer constant readjustment, these changes, no more than the ever renewed elements in the physical body, do not prevent it from being in the full possession of life.

An empirical psychology is enclosed in a rational psychology as the kernel is contained in the shell. What the latter affirms is that these mental powers, empirically discovered, are the germ of a complete life, self sustained in all its parts. The independent and creative quality of intellectual activity is pointed out, and we are led to see that we are in possession of true knowledge according to the obvious purport of our daily experience. The mind is justified to itself.

There are three forms of mental activity: that of the senses, furnishing the material of perception; that of the reason, giving the forms of knowledge; and that of the understanding, uniting these two in judgments. Each of these three is discussed in reference to its constituents. The elements of knowledge due to the external world, the elements due to the mind itself, and the completed product due to their union in thought, are brought out in their equal and adequate authority.

The chief ideas, or form elements by which crude sensations are transformed into clear perceptions are space and time. These are in no way contained in the sensations themselves but are brought by the mind to that mental construction by which these sensations pass into completed terms of knowledge. The sensation is sterile without the form, and the form is empty without the material given by the sense. Both are dependent and independent; both are essential parts of our knowing. All the efforts of the empiricist to obtain either of these form elements, space or time, in sensation itself are merely a cunning rehearsal of the conditions by which they are called out in the mind. All organic response, or instinctive response, of the physical man to the impressions of sense fall short of knowledge till the rational construction under these rational forms has taken place. Faithful analysis gives them both, and is compelled to refer them to different sources, the sense and the reason respectively. Thus perceptions, the earliest product of the mind, which are to lie at the foundation of knowledge, are found to contain constituents from the external and the internal world, blended by reciprocal and inseparable action in one transparent product with the same certainty with which oxygen and hydrogen combine in water.

These first and relatively simple materials of an intellectual world come at once under the constant and more extended

action of the judgment, till they form parts of the general scheme of nature; constituents in our experience more or less extended according to our forms of inquiry and of activity. This addition of units, this weaving them together into the intellectual fabric of life, proceeds under the form elements of substance and cause. The reason adds to each group of phenomena the sense of reality, the feeling of an underlying something, more frequently called substance, which remains as the constant source of these impressions. The impressions and the reality are the equivalents of each other and make up a firm and uniform experience.

Associated with this notion of substance is that of causation. The forces involved are not passive but active forces, which govern phenomena in an orderly procedure, in a form of activity defined by existing circumstances. These two form elements of substance and cause enable us at once to build up a knowledge of experience more or less extended according to the attention we give it. This knowledge, which we are especially wont to call knowledge, contains, like perception, two different and distinct elements, one finding entrance through sensation and one through reason. Without the constructive form, knowledge is blasted in the bud; without the fixed terms of phenomena, it becomes visionary and fanciful, clouds which disappear while we look at them. Here, again, we have the two sources and constituents of truth, neither of any validity without the other.

So far the inquiry is kept within the ordinary forms of knowledge, and we find that the things we see and feel give rise to perceptions and judgments which contain two elements, parts contributed by mind and matter in reciprocal action. Our construction of events into an intelligible experience thus becomes a joint product of disparate agents. What men have everywhere and from the beginning regarded as knowledge, knowledge self consistent, reliable and capable of increase, is found, under clear and fair interpretation, to contain two forms of activity, and to reach completeness by means of them both.

We now come to transcendental inquiries, which the human mind is ever making, led to them by other form elements which remain to be filled out, and which carry the thoughts forward to their most comprehensive expression. The mental forms under which this wider survey goes forward are equally plain. The first of them is personality, that assemblage of powers which, under a universal rendering, give us the sense of manly endowment, spiritual presence. Dr. Hickok conceives this soul-power as involving unity, spontaneity, autonomy and liberty. They are not so much separate parts of one life as separate ways in which one life may be regarded. A pure

intellectual process, that in which the mind of man is most detached from physical relations, offers itself as something wholly distinct from a series of causes. Take the conception of a circle and a discussion of its qualities. Any affirmation we make concerning it, as that the areas of circles are to each other as the squares of their diameters, is established in a sequence of thought which has no resemblance to a series of causes, as when a rock is split by repeated blows. It is a process of its own order, a thought process, which justifies itself to the mind, and owes its conviction wholly to that fact. Such a movement of mind is spontaneous, autonomous and free. We often speak of liberty as if it found sole expression in an act of will. The truth would seem rather to be that liberty belongs to mind as mind, pursuing its inquiries according to its own nature, and making them less complete or more complete according to its own purpose. A process of thought cannot go forward without this liberty and not lose its own character, its own connections, its own integrity.

One of the most obscure and controverted directions in which the reason of man brings form to human judgment is the law of right, the law of righteousness. Such a law lurks in men's mental processes, in one direction or another, with one or another degree of completeness and of authority,—the more thoughtful the man the more authoritative the law. This law of right, which enters so often to constrain the actions of men, is closely associated with happiness, with conventional sentiment, and with the forms and enforcements of social and civil law. Yet it transcends them all, struggles to reconcile them all, and gives to them a distinctive pungency which they cannot otherwise obtain. The law of right is constantly changing its form and direction in men's minds, absorbing into itself many considerations of pleasure, of the growth of individual and general prosperity, and yet remains supreme over its constituent and associated ideas, inexpugnable, ever reasserting itself above all denial and beyond all explanation. The sense of right in many persons in reference to many forms of action, asserts an authority which they cannot escape, and which adds to disobedience a sense of shame and humiliation they cannot soften. The magnetic needle may easily vacillate and be much deflected from the pole, yet it still remains a constant guide in our voyages. The lines of the spectrum, aside from any explanation, are fixed characteristics of the elements which involve them. This sense of law, more supreme as men advance in intelligence, is inseparable from the rational mind in its outlook over the spiritual world. We may offer as a guiding principle, the greatest good of the greatest number, and yet it is the sense of right which interprets the precept,

not the precept which shapes the sense of right. The sense of right still remains to us to tell us what the greatest good is, and to enforce upon us as a law of action this good in reference to ourselves and in reference to others. A sense of law, of supreme law, still to be expounded in many directions and to be enlarged as it is expounded, remains with us; and by virtue of it the world becomes ethical, a field undergoing, slowly it may be but certainly, a spiritual construction. A universal expounding law is present which works its way experimentally and rationally into the government of the world, and makes of it the Kingdom of Heaven. Thus we find the world to be a spiritual kingdom whether we have or have not recognized its King. A notion which transcends all final statement is with us to give form to our lives.

If we add to freedom, exercised under law, both of which we refer to the spontaneous activity of mind, the notion of the infinite and the absolute, we are able to give to the universe, to the largest procedure of the world, an exposition which, like a discussion of the properties of a sphere, may still leave out many things we would be glad to know, yet holds for the mind the germs of truth which quicken and gratify to the utmost our spiritual life. Under these conditions the sense of intelligence, and ultimately of a Supreme Intelligence, comes to us as the true power of this system of things of which we are a part. With it arises a belief in immortality as alone giving room enough and incentive enough to carry forward these impulses, which we are beginning to understand, into a kingdom proportioned to their own magnitude.

We both see and feel that there is an evolution, and that this evolution is one which will justify all the ways of God toward man. These conceptions make the world supremely rational, though the lines of order may so far have been traced by us inadequately and obscurely.

This is but a summary presentation of the Rational Psychology, a volume of seven hundred and seventeen octavo pages, containing besides its primary theme many subsidiary illustrations and criticisms. The mind of the author was so thoroughly occupied with the constructive force of the human mind, that he proceeded at once to bring its regulative thought to the interpretation of the physical world about us. The first volume in this direction was Rational Cosmology, published in 1858, presenting a speculative physics and biology. In 1872 it was followed by Creator and Creation. These are extraordinary works in the sustained attention they imply, and in the extent of the phenomena which they embrace. They can receive from us only a brief presentation.

The preface of the Rational Cosmology contains a statement

which foreshadows the purpose of the volume. "It will thus ever be true of the finite human reason, that with the mere facts of nature he can never rise to any science of nature, and with the partial apprehension of the principle he can never follow it out in all its necessary determinations, and, hence, his only sure progress must be, first, an apprehension of the principle, more or less inadequately, and then a following out of the principle in its necessary laws by a reference to the actual facts that have already been determined by it. . . The facts are nothing for philosophy except as seen to be determined in their principle, but are much for philosophy when used by the insight for the development of the determinations of principle." The first chapter expands the idea of a Creator and the second and third chapters, constituting the body of the work, give a brief statement of the conception of matter as a product of mind, and then proceed with an extended tracing of the forms and laws of matter as known to us in a large variety of departments. The volume is a tentative application of a rational idea of matter to the various facts which are united under it in the general system of things. Thus the world becomes intelligible throughout by an apprehension of its controlling principles.

The second volume, whose contents evidently grew into distinctness as the author's mind, in the progress of years, came to dwell on these primary conceptions, elaborates more fully the fundamental nature of matter, and the construction which would arise under the antagonistic, diremptive and revolving forces which lie at its centre, and issue in a creation; a preparation for the various forms of life, and a rational product springing from the reason of God and addressed to the reason of man. The second volume covers the same primary ideas as the first volume, and employs them with the growing distinctness and confidence which arise from long meditation on them. The two books give a very clear example of what frequently occurs in philosophy. Increased familiarity comes to be the equivalent of increased proof. The mind conceiving its ideas ever more clearly is proportionately impressed with their explanatory power, repeats them under their later forms and justifies them afresh with each enlargement of light.

The second preface contains this statement in line with the one already given. "We must recognize a higher spiritual faculty than sense-experience, as an organ of spiritual philosophy which shall abundantly comprehend and confirm our theology; and therein may all scepticism be fairly met and answered. The phenomena of nature must be seen to be ordered by essential forces back of the appearances; and also faith in theism must rest on truth known to be beyond nature

and determining the order of nature, though known by the insight of reason in nature."

In the same year, 1872, in which Creator and Creation was published, appeared Humanity Immortal; or Man Tried, Fallen and Redeemed. This work came as a natural completion of Rational Psychology and Rational Cosmology. It gave the final defense and support of the system of theology which the author had for so many years presented. His conception of the divine character and of human liberty led him to regard human destiny, man's relations to God, in their most inspiring form. The comprehensible and the hopeful received far more emphasis than the obscure and portentous, and thus it became a most assured and grateful issue, that we, too, should reach the presence of Pure Reason.

The closing volume, Logic of Reason, was published in 1875, and was a return to the key of the whole structure. Dr. Hickok was so profoundly occupied all his life with his ruling idea that no additional light was without interest to him, and no repetition disturbed him. Enlarged apprehension came to him as superior light on the spiritual landscape, a pushing forward one step further toward the coming day. Dr. Hickok had also such a constant sense of the partial and inadequate presentations of truth in current forms of philosophy that some critical and constructive and corrective process was ever arising in his mind, and pushing forward in immediate, effective use.

Thus the Logic of Reason opens with a full discussion of transcendental and of empirical logic, and then passes on "to discuss those forms of force and life which are the substance and essence of the universe." Reason is put to the test of reading in the facts of experience the principles conditional for it, the things which have preceded it, and to determine the order of inherent, adherent and coherent connections in all phenomenal observation. Whatever else we may think about the philosophy of Dr. Hickok, he did not propose to himself any secondary or insufficient purpose.

We are not to conceive of the philosophy as thrown off at a single heat. It was rather a growing light to which the eye became more and more accustomed, by means of it gaining a clearer revelation of the visible and invisible world. Hence the constancy with which he returns to it, and his sense of something more adequate in each fresh presentation. His mind worked like the mind of Spinoza, intoxicated with a conjoint vision of nature and God. During a long, spiritual, thoughtful and peaceful life, the dawn of reason passed into the dawn of philosophy, and the dawn of philosophy into full day in which one seems to see even as he is seen. It is no

more necessary that the thought by which we apprehend the mind of God should be altogether perfect than it is that the light which discloses the world should be everywhere present and complete.

I am not willing to close even this brief sketch of the system enforced by Dr. Hickok without some estimate of its validity. The Rational Psychology, passing by secondary and verbal criticism, seems to me to go straight to the root of our intellectual life. We cannot, by any adequate analysis of our sensuous experience, reach the forms of thought which belong to a rational handling of the world. Moreover, this joint product which arises between mind and matter is in harmony with what we meet everywhere. No finite cause by itself alone creates and gives character to an effect. In every effect, every combination, we have at least two agents which concur in the result. Nothing lies wholly passive to receive the action of other things, wholly active. We have also in this philosophy of reason a vindication of the fundamental constitution of the mind and an acceptance of universal knowledge. Man, in the repeated and spontaneous use of his powers, has reached results which combine these two elements, physical fact and intellectual interpretation, in a manner accordant to this conception. Nothing which disturbs the foundations of general knowledge can be conceded, for this is to render knowledge self destructive.

A most important criticism to be made on this portion of Dr. Hickok's work is that he speaks of consciousness as an inner sense. It may much better be regarded as itself a form element, essential to a large class of phenomena; those we know as intellectual phenomena. What space is to physical facts that is consciousness to intellectual facts.

When we come to the use made of this psychology in cosmic interpretation, conviction drops off. The view presented casts light only here and there by accident, as it were, and leaves the great mystery of method untouched. My first contact with Dr. Hickok was, as I have said, in 1851, in the seminary at Auburn. I had already begun to find difficulties in the religious dogmas in which I had been brought up. The atonement seemed a human device consistent neither with ethical law nor God's revelation in daily affairs. I was glad to give weight to Dr. Hickok's opinions as relieving an uncomfortable pressure. He did not attempt to overcome my doubts by any severe rendering of the idea of justice, but urged that the atonement was to the human mind the most obvious and adequate presentation of the divine mind toward sin and toward men. Rejection of sin on the one side and grace on the other were clearly and adequately brought out in this doctrine. This

reasoning for a time satisfied my mind, but later the old difficulty revived. This method was not in harmony with the government of the world, the government expressed in the parable of the prodigal son; not in harmony with the fact that repentance always carries forgiveness with it. Thus once more dogma became a scheme put upon the world and not found in it.

I had from the beginning much the same feeling in reference to his conception of the forces, antagonistic and diremptive, by which he proposed to explain the universe. They brought their own difficulties and gave no revelation as to the nature of things about us. When we are dealing with the most familiar phenomena, we get quite beyond our depth, if we undertake to put another series of facts back of them. Take, for example, a ball flying through the air under a blow from a club. Does the ball differ from what it was before it was struck, and how will it again differ when it is brought to rest? The facts are uniform and plain, but how came they to be exactly what they are? It helps us very little to imagine the ball in motion to be charged with something we call force, and to lose it again when brought to rest. The acquisition, the intermediate state and the loss still remain mysterious. To inquire exactly what the phenomena are, that is science; to see the purpose subserved by them, that is philosophy, but any imaginary intervening mechanism is not even knowledge. When we come to the how of things, it is to get over the insuperable difficulty which arises in the mind that we assert the presence of Infinite Spirit. We can give to intermediate notions of matter and force no such form as to remove the sense of ignorance we experience the moment we reach them. It is equally a false form of knowledge to deny the reality which we cover by matter and force and to attempt to explain it. True philosophy stops when it is through, and offers no explanation of noumena beyond the noumena themselves. The noumena are not in the explanatory series, but superinduced upon it. We accept them as inseparable suggestions from phenomena, known in the degree in which we know the phenomena, and playing their entire part in connection with them. What we know as force has many phases, and each phase finds expression exclusively in one set of phenomena. The more absolute this identification of each force is made with its own phenomena the more adequate our knowledge becomes. We are not, like the Indian, to explain the steam engine by a horse enclosed within it; the engine explains itself. The simplest exposition of gravity is the bare fact that ponderable bodies attract each other. This statement is the substance of what we know, and all the knowledge of which we can make any use.

Dr. Hickok is by no means alone in putting notions back of notions, vague realities behind obvious realities. Yet no philosopher advances one step in knowledge by this method. Take the doctrine of inheritance. What we need is the facts in fuller measure, to accept them in their own form and to keep away from them any unverifiable conceptions—conceptions which are sure to affect our estimate of the facts themselves. Gemmules and physiological units may seem to help the doctrine of inheritance, but before we are aware of it they will divert attention from what is, to what ought to be under their intermediate agency. We are overrun just now in psychology with fanciful forces which we can in no way locate or expound. Visions and suggestions, shaped in an unconscious region, come crowding up by a subliminal passage into the mind where they serve to confuse in wonderful ways the actual phenomena of intelligence. The more we shape for ourselves such appliances the less we shall know of what are the actual, verifiable relations of thought and physical facts; we shall slip away from the world of realities into one of shadows and moonshine. The fact and adherence to the fact are the first lesson of sound inquiry. If what we term "new psychology" were called neural dynamics we should know much better what we are about.

While pure mathematics is an obstacle which the empiricist has never been able to push out of his way, it has also at times been a snare to the intuitionalist. Its conclusions are so absolute, so independent of experience, that it seems to move in a region quite above facts. Its units are perfect units, its definitions without ambiguity, and, wherever numerical form alone is involved its conclusions are unimpeachable. When, however, in mixed mathematics the discussion pertains to real things, the absolute quality disappears. We manage with much labor to secure proximate units in weights and measures, but when we come to estimates of mind, as in values, we are quite at sea. The purchasing power of a certain number of dollars is constantly in fluctuation, has no measure. It turns on the form of currency, the state of credit, the market in which it is tested, the articles purchased, the state of mind of buyer and seller. Values, like tides, are coming in or going out, and are liable to play us unexpected tricks.

When we reach social or artistic or intellectual or virtuous quality our numerical estimates are so much at random that we rarely offer them. Statistics, their most common form, themselves need interpretation before we can by means of them either affirm or deny anything.

We are disposed to push mechanical notions and measurements quite beyond their application, simply because they do

serve at times to render our knowledge so complete. Even the universal belief that matter is indestructible is an induction resting on relatively few facts. The equivalence of forces is by no means the broad principle which we sometimes think it to be. It is not an assertion that forces in distinct amounts displace and replace each other, but that a few forces, under mechanical relations, may be made the means in expenditure of calling out other forces of a like character. Fuel consumed in a steam engine is not replaced as regards force by an electric accumulation, or by mechanical energy. In its own dispersion, it gives rise to a distinct accumulation of force which may in part take its place, awaiting in turn some other form of dispersion. The locomotive runs one hundred miles. It might have run more or less, or stood still on the track. The heat, ready to produce motion, is lost, and does not reappear in any other form. There is a conditional dependence of one form of force in its generation on another form, but each remains subject to its own circumstances. In the solar system forces are constantly suffering dispersion in large amounts.

The forms of undue extension given to conceptions by the empiricist and by the intuitionalist are often much alike. In the discussion of the origin of species, there are two considerations of very unequal importance. The first is how come there to be suitable varieties, in the character and amount of the changes involved in them? The second is the tendency of these varieties to survive. The survival of the fittest approaches a truism. No one is disposed to deny it, and it is kept in the foreground. How the fittest comes to be is a much more difficult inquiry, and is inadequately treated. The intuitionalist can readily, if any given effect is to be secured, insist that means, akin to those actually employed, become necessary. This assertion is not expounding why, in spaces and periods unoccupied, these results, or indeed any results, must arise. A movement once started, a certain power of prediction goes with it, but whence the movement itself arises is not a forecast of our rational powers. So it is in any affirmation we can make concerning any actual event, the necessity lies in the relation of one part of it to other parts of it, and not to it as one whole. A strong argument for a Divine Agent may be framed from the profound and innumerable interdependencies of the physical and the intellectual worlds, from the fact that they together unite in one universe; but any necessity which goes to show that these results are inevitable, locked up in antecedent connections, reduces not enlarges our sense of the need of a Divine Presence.

Our true attitude seems to be a close and extended inquiry into things as they are, a sense of the mystery of that power

which, point by point, makes them what they are. These are the facts with which we have to deal. A universe according to Spinoza, or according to Spencer, or according to Hickok may seem for a moment more intelligible, but is in no way so instructive, so stimulating, as a universe in which the mind moves freely, a universe constantly disclosing new phases of power.

Many theories to which we are disposed to attach importance simply hide that eternal development of thought from thought, method from method, which confronts and feeds the mind, and puts it on terms of intercourse both with the known and the unknown. We certainly may know all we can know, see all we can see, but the thin mist of speculation we spread over the landscape often conceals far more than it reveals. It has been affirmed by one entitled to an opinion that the philosophy of Dr. Hickok is the most comprehensive and original of any, which up to his time had appeared in America. This statement seems to be just, if we consider the circumstances under which it arose, its scope, and the soundness of thought and method.

It was brought forward as a defence, on the one hand, against the stolid assertion of Scotch philosophy and, on the other, against the volatile speculation of Transcendentalism. The two manuals, one on psychology and one on ethics, marked an era in instruction in Amherst College and became influential elsewhere.

This system also covers the entire field of philosophy. Dr. Hickok, during a long life, had in mind the complete philosophical problem, psychologic and cosmic. He was profoundly interested in any philosophy which strove to cover and support human knowledge in its several forms. This interest is seen in his frequent criticisms, and in his extended treatment in his Logic of Reason of the various comprehensive forms of thought hitherto offered. His feeling was that philosophy stood for a well rounded system applicable to all forms of inquiry. It was this conviction that led him to take up a second time, after so long an interval, the cosmic problem.

The justness of his general method, notwithstanding the undue extension given it in physical discussions, must be freely conceded. His seven volumes, all devoted to one self-assigned task, started in psychology, a study into the scope of human powers, and at the close returned to it in the Logic of Reason. Though the rational element was given the foreground in every inquiry, yet the method of approach was primarily empirical. His rational and empirical psychology alike rest on a careful analysis of the facts of consciousness. Knowledge in its incipiency is shown at once to hold the empirical substance and the rational form of truth. His cosmology, not-

withstanding its speculative scope, deals directly with the forces of the world, attractive and diremptive, and strives to make out of these the substratum of all physical things. Dr. Hickok thus achieved a comprehensive system of philosophy, pervaded in all its parts by a temper both rational and empirical; a system venturing further and with more sobriety into the field of knowledge than any which had gone before it in America.

THE EFFECT OF PRACTICE IN THE CASE OF A PURELY INTELLECTUAL FUNCTION

By EDWARD L. THORNDIKE, Teachers College, Columbia University

The mental multiplication of one three place number by another affords a convenient means of studying several interesting psychological topics. For instance, the process affords perhaps the best brief test of attention of those so far used; the nature of the images in which one thinks is shown perhaps better by such a real mental problem than by questions concerning one's power of voluntary recall of images; the efficiency of the process is readily measurable so that it serves well as a test of fatigue or practice. It is especially advantageous for the study of practice because it requires no apparatus and offers a case of improvement in a function which a student of very slight psychological training can readily understand and measure. The experiment which is reported here might well be made as a part of the class work of a course in psychology.

I shall not rehearse all the details of the management of the experiment or all its results, but shall confine this report to the facts necessary for the understanding and criticism of certain conclusions concerning the amount, rate, progressive change of rate and spread of improvement.

THE EXPERIMENT

After preliminary training with three or four examples in mental division of a 6 place by a 2 place number, and two examples in mental multiplication of 3 place by a 3 place number, 33 individuals multiplied mentally from 50 to 96 examples like those quoted below,[1] which are a random selection in random order of the examples made by putting any 3 place number containing no digit lower than 3 and repeating no digit, with any other such 3 place number.

Of the 33 individuals 1 did only 50, 1 only 60, 1 only 66, 1 only 75, and 1 only 85 examples. The remaining 28 did 96 each. In what follows only the 28 individuals will be considered, unless a special statement to the contrary is made. As a rule 5 or 6 examples were done per day. The time of day varied amongst

[1] 657 398 479 358 589 395 396 864 739 983
964 367 476 537 745 359 953 659 459 394

individuals and in some cases within the different practice periods of the same individual. It was impossible to prevent these variations in conditions without imposing great inconvenience on the subjects. Such variations increase somewhat the variable errors of all the determinations, but if one is careful to interpret differences in results with full awareness of these differences in conditions, no serious harm need result.

Each example was done as follows. A time at which to start was set and recorded. At this time, say A. M. 8 hrs. 40 min. 30 s., the example was taken up, looked at long enough to fix the two numbers in memory so well that they could be repeated from memory and further memorized without the paper. The example was then laid aside, no sensory aids were used, and when the full answer was obtained it was written down and the time recorded when the last figure of it had been written. If the subject was interrupted *ab extra* as by a knock at the door, the record was omitted, the same example being done a day or so later. The subjects were allowed to examine their results in comparison with the correct answers.

Reduction of the Scores to One Variable

For the purposes of this article the following scores were used: (1) The times taken in doing the 1st, 2nd, 3rd, 4th, 5th, 91st, 92nd, 93rd, 94th, 95th, combined times for 1-5, 91-95, 86-90, 1-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, and 81-90. (2) The errors made in each of the above examples or groups of examples, an error being defined as any wrong figure in the answer, 6 errors being the worst possible record for an example in accuracy.

When it is desirable to have a single measure of efficiency, I transmute errors into time by adding 1/10 of the time taken per example in lieu of each error made. Thus a record of 200 seconds and 1 error for an example becomes 220;—a record of 2,500 seconds and 13 errors for ten examples becomes $2{,}500+(13\times\frac{2500}{10})$, or 2,825. Any such scheme of allowance can be criticised and I do not pretend that this is the best one that could be found for the present case. It is not far wrong, however. The gross figures are given in Table I so that any one who chooses may apply any other scheme for equating time and errors. It will be found, I think, that with any rational scheme the general conclusions of the study will remain as they now are.

The Amount of Improvement

The facts from which the amount of improvement is estimated are the records of the first five examples done and the first five of the last six done, taken in connection with the time of day when it differed in the two cases. By observing

TABLE I. — GROSS SCORES

Individual	Sex	First Five		Last Five		First Ten		Second Ten		Third Ten		Fourth Ten		Fifth Ten		Sixth Ten		Seventh Ten		Eighth Ten		Ninth Ten	
		Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.	Sec.	En.
1	F	1022	16	764	1	2004	20	2565	20	2285	10	2259	27	2205	14	2081	16	1826	21	1528	21	2093	23
2	F	1243	22	680	18	2298	44	2500	38	2426	35	3131	35	2864	40	2705	48	1688	38	1703	37	1709	26
3	F	2040	2	880	3	4200	9	3120	15	3305	15	2070	7	1990	14	2220	7	2058	11	2412	18	2406	2
4	M	2130	7	600	1	3390	13	2580	6	1740	8	1275	6	1050	2	1020	7	1110	2	960	4	990	7
5	F	3000	12	1230	5	6300	24	4700	32	3550	23	3240	24	3375	15	2950	16	2730	15	3300	18	2685	12
6	M	1315	5	867	3	2422	15	2433	13	2470	19	2352	12	2313	18	2112	17	2053	19	1865	14	1862	10
7	F	2185	16	1803	5	5500	22	7630	26	6877	16	8483	14	6800	11	6248	9	6519	12	4440	13	4452	7
8	F	1980	14	990	11	4440	25	1950	40	2400	25	2160	13	2670	20	1785	17	1395	23	1855	16	2080	15
9	F	1370	15	550	2	3181	27	2493	27	2100	14	1615	18	1701	13	1400	15	1327	16	1010	14	1085	6
10	F	2400	12	1230	10	3570	17	3375	6	2778	8	2445	4	2445	27	2527	11	2305	14	2167	10	2400	21
11	F	3535	12	1915	5	6442	23	5331	19	5317	17	5160	21	4135	14	4231	20	4108	18	3548	17	3656	10
12	F	2834	23	1511	10	5616	40	6437	4	4924	18	4196	18	5250	12	4289	19	3320	9	3286	16	4074	15
13	M	2765	6	377	6	4695	13	3447	15	2461	11	2165	10	1988	7	1597	11	1256	8	1109	15	947	10
14	F	900	3	525	3	2200	5	2765	8	2945	3	1895	8	1935	4	2105	8	1660	8	1275	8	1170	4
15	F	5340	0	2369	0	9180	1	9090	10	6293	11	6690	13	5387	7	4702	5	4495	5	3932	7	4480	6
16	F	1870	12	450	1	3505	22	2855	18	2285	20	2065	9	2467	10	2045	13	1470	12	1700	16	1315	13
17	F	2665	19	637	10	4535	37	3532	21	3201	19	3260	17	2295	15	2270	11	1823	14	1675	22	1720	18
18	M	3000	16	960	9	6120	28	4800	13	4080	16	4560	10	3420	21	3120	14	2760	21	1740	25	2460	20
19	F	2235	4	1080	0	3915	10	3660	8	3660	9	3225	9	2385	6	2370	5	2400	3	2265	5	1905	4
20	F	2040	15	825	3	4020	26	4105	8	3060	18	3375	10	2550	13	2355	5	2970	8	2565	21	2055	12
21	M	2530	11	725	17	4325	26	3825	31	3323	29	2655	32	2845	25	2365	23	2340	18	1960	30	2220	27
22	M	2368	2	971	0	3792	2	3553	4	3079	4	3258	6	2912	0	2845	5	3085	2	2294	2	1939	0
23	F	1590	13	950	14	3450	16	3790	17	3245	16	2365	5	2025	12	2290	9	2520	17	2050	15	2260	9
24	F	1857	2	740	12	3657	10	2801	23	2843	9	2347	15	2601	9	2503	19	2334	10	2232	11	1603	18
25	F	3010	21	1500	7	5135	36	4700	26	4200	29	3780	19	2990	26	4084	19	3460	21	2630	25	3760	22
26	M	1565	6	780	5	2710	15	2225	17	2465	20	1955	11	2145	18	2205	12	1750	5	1645	3	1870	11
27	M	2720	5	820	4	4870	13	4000	18	3270	10	2390	11	2615	10	2400	13	2430	16	2160	11	2280	15
28	M	3525	9	1022	10	6340	15	4430	22	3631	16	3174	18	2960	13	2688	16	2418	13	2394	13	2139	15
29	M	.....	....	.....	....	3750	11	3580	21	3355	21	2348	14	2166	6	.....	....	.....	....	.....	....	.....	....
30	M	.....	....	.....	....	4145	13	3281	11	2379	9	2405	10	2008	19	1550	11	1660	13	1700	12	.....	....
31	M	.....	....	.....	....	4672	7	4448	2	3693	6	2154	7	2019	2	1798	3	1428	4	.....	....	.....	....
32	M	.....	....	.....	....	13157	2	13115	12														

the gross scores, and not only the scores as equated for errors but also the cases where the initial and final records were identical in respect to accuracy,[1] we can make a reasonable prediction concerning the reduction in time which would have occurred had the individual worked at the beginning and at the end of the practice with the same accuracy.

The ratios of such scores for the last five examples to those for the first five were as follows: 14, 20, 21, 23, 26, 28, 29, 30, 31, 32, 34, 36, 39, 42, 42, 44, 47, 48, 50, 50, 50, 50, 52, 58, 59, 60, 64, 70. The median is .42 (P. E. .02) and the median deviation from it is .10. The separate scores are subject to somewhat large variable errors so that it would be unsafe to infer much from the range of variation.

This estimate of the general amount of improvement would be very, very slightly altered by any reasonable system of equating errors and time. This can be demonstrated by actual trial of such systems and also by taking those cases where the difference in accuracy between the first and last five examples was nil or slight. For the eleven such individuals the median of the ratios of the scores of the last five examples to the corresponding ratios of the first five was .41 (P.E. .03).

The fact that these mature and competent minds improved in the course of so short a training so much as to be able to do an equal task in two-fifths of the time first taken is worthy of attention because of its bearing upon the problem of the influence of improvement in one function upon the efficiency of other functions. It is clear first that the training which this group had had for twenty odd years in remembering facts, resisting distractions and carrying in mind a complex series of relationships had left this special function of mentally multiplying a three place number by a three place number in a very easily improvable condition. Such could not have been the case if the components of that previous training had exerted each even a very moderate general influence. It is clear also that this improvement of over fifty per cent. must have been restricted closely to the special function involved. The most ardent advocate of the general influence of specific practice would not, I judge, claim that ten hours' drill in any one thing could improve an already well educated adult 50 per cent. or 5 per cent. or even 1 per cent. in the average of all his intellectual processes.

In estimating individual differences in the amount of improvement and in estimating the relations of these differences to other mental characteristics of the same individuals, the ratios listed

[1] This comparison will give only a limit, for it means for a person who improves in both speed and accuracy that a better early record than usual is compared with a worse late record than usual.

above must not be taken thoughtlessly at their face value. For a person to change from 400 seconds per example to 200 is not necessarily the same amount of improvement as for him or another to change from 200 seconds to 100 seconds. The second is probably an improvement which fewer individuals would be capable of, which the same individual would take longer to attain, and which, if analyzed into its constituents, would be found to be different from the other. To call the two equal as fractions must not lead one to infer any thoroughgoing equality in the facts which the fractions only partially represent. The relation of one-half of a man to a whole man is by no means the same as the relation of one-half of an earthworm to a whole earthworm, or of one-half of a dollar to a whole dollar. In fact, every measure of improvement by a gross difference or by a ratio must be accompanied by a statement of the initial or final gross actual ability.

It is beyond the province of this article to discuss the intricacies of methods of measuring change. The aim here is only to show and very roughly measure those differences by a method to which no one can properly object. Consider, then, the following eight records:

GROSS RECORDS

Initial (I)		Final (F)		Ratios F/I		Estimated Single F/I Ratios, errors being equated into time
Time	Errors	Time	Errors	Time	Errors	
2765	6	377	6	14	100	14
1870	2	450	1	24	8	20
2665	19	637	10	24	53	21
2130	7	600	1	28	14	26
2185	16	1803	5	82	31	70
1590	13	950	14	60	108	59
3535	12	1915	5	54	42	50
2834	23	1511	10	53	44	50

Now whether we regard a poor initial record as favorable to later improvement or not; whether we mean by twice as much improvement twice as much gross reduction in time or twice as much percentile reduction or twice as low an ending-beginning ratio—in any case we find some one of the first group who improves two and a half times as much as some one of the second group. There is, then, a range of at least two and a half to one among the 28 students on any reasonable and on

most unreasonable methods of scoring improvement. Nor would the unreliability of the measures of individual improvement be any more likely to decrease than to increase this range.

An investigation of the relationship of this difference in amount of improvement to other differences amongst the 28 individuals becomes necessarily very complex, and I shall not present the evidence here. There is a positive correlation with general intellectual achievement, a correlation which I estimate roughly as at least .4, possibly much higher.

There is apparently a zero or a slight negative relationship with the vividness and fidelity of visual images of the numbers, partial products, etc. The proportions of those of strong and of weak visual images were closely the same in those improving much and those improving little. Of the few cases who reported increase or decrease in the strength of the visual images of the numbers during the course of practice, those who reported a decrease improved somewhat more. It is also significant that more individuals reported a decrease than did an increase (9 and 3 respectively).

The Limits of Practice Effect

For the function practiced, the multiplication of a three place number by a three place number, the physiological limit is, for a capable person, very, very low, for such a person could, by devoting himself absolutely to it long enough, arrive at a knowledge of a large part of the multiplicalion table up to 999 times 999, and at an absolute knowledge of the multiplication table up to 99 times 99. There is no question of the attainment of such a final limit of practice in this experiment, but one individual (No. 4) did reach a condition beyond which the remaining practice of the experiment itself did not appreciably improve him. (See Fig. 1.) Such was possibly the case also with individual 9.

In view of the fact that the ultimate limit is far below the ability recorded by subject 4, the arrest of practice effect at this level may be taken to represent a 'plateau' from which the curve would sometime descend.

Changes in the Rate of Improvement

Practice in mental multiplication with two three place numbers is not well fitted to show changes in the rate of improvement because of the large variation in the result for any one example which a slight lapse of attention or memory may cause, though possibly it is as suitable as any equally complicated and difficult purely mental function would be. For this special purpose the presentation of the numbers themselves to sense perception, or the use of two place numbers, might be better. However, certain facts are shown with sufficient clearness and reliability.

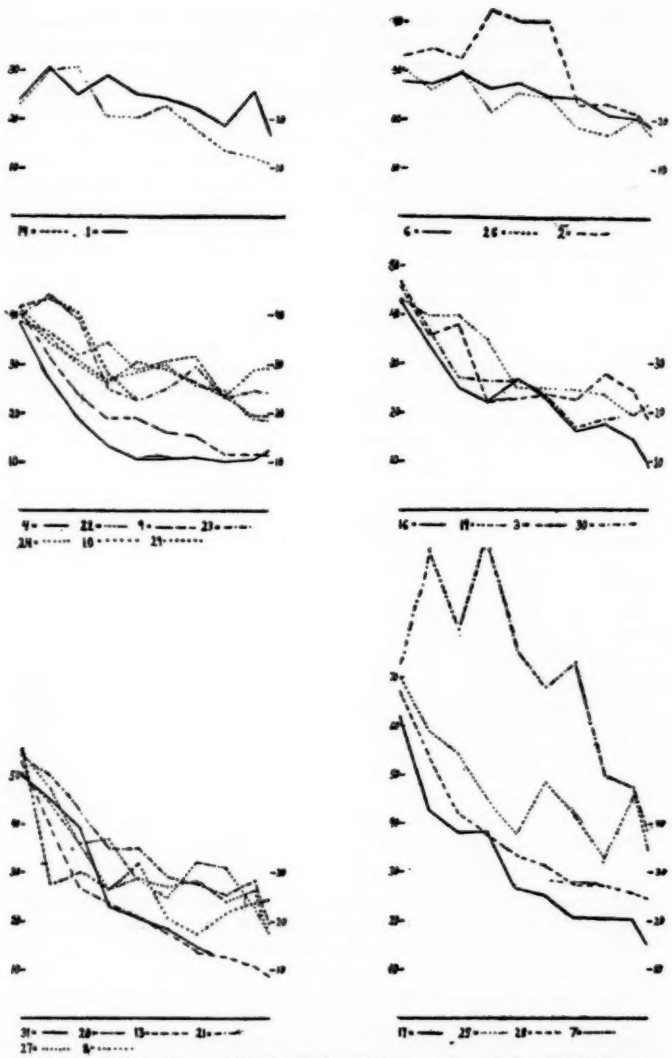

FIG. 1. The changes in the Rate of Improvement in Individuals. The course of practice runs from left to right, the whole abscissa-

length equalling 95 examples. The length of the curve represents (in hundreds of seconds) the time required to do ten examples plus the allowance for errors made. Individuals are grouped according to their degree of ability in the first ten examples. For the reasons stated on pages 375, 377 and 378 only the general sweep of each curve should be considered in arguing concerning individual differences.

In general, the earlier periods of practice show the greatest gross reduction in the scores. The graphic records of the individuals (Fig. 1) show this change.

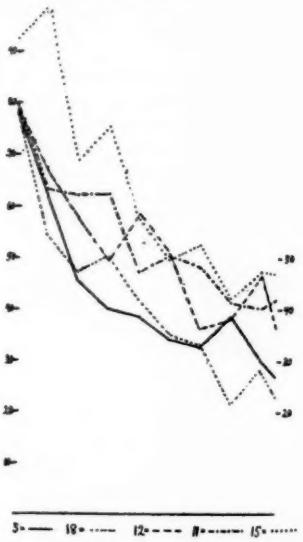

FIG. I (Continued).

The apparent changes in the rate of improvement, that is the forms of the practice curve, are widely different amongst different individuals. This, again, is clear from the graphic records. These apparent changes in the rate of improvement are due in part to the variations in conditions from which the effect of mere practice *per se* must be freed before one can prove that the law of change in the rate of improvement varies with individuals and, if so, how far it varies.

If, however, there were one law of change of rate of improvement from the start through this period of practice identical for all the 28 individuals, we could, from the present data, ascertain fairly closely what the law was. We could, that is, answer the following question:

Considering the 28 individuals as all starting at "the ability given by 10 to 20 years of general experience with mental work," and ending with 'the ability given by 10-20 years of general mental work plus the mental multiplication of 95 examples,' and considering the change in their rates of improvement from the start to the end to be due to one general law of change of rate plus individual deviations from it due to internal and external disturbing factors, what is this general law of change of rate?

The answer to this question is given by the continuous line of Fig. 2, which presents approximately the one rate of change from which the 28 separate rates of change could come with the least improbability as a result of disturbing causes. It is obtained by eliminating the total amount of change from consideration in every case by taking the *differences*—score for examples 1 to 10 minus score for examples 11 to 20, and so on up to 81 to 90, and dividing them by the total change, *i. e.*, score for 1 to 10 minus score for 81 to 90. We have, then, 28 practice curves all beginning at 100 and ending at 0, and can find the one such curve which represents the central tendency of them all.

It might well be that though no such one law held for the change of rate of improvement from the beginning to the end of the practice given in such an experiment, some one law

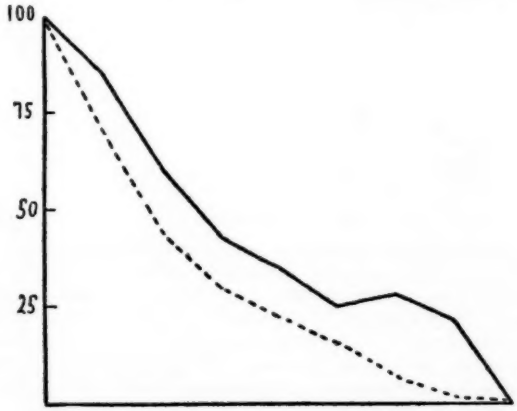

FIG. 2. The General Law of Change of Rate of Improvement in the Case of each of Two Suppositions.

might hold for this change of rate of improvement from a given ability (say to do 10 three place examples in 50 minutes

with 15 errors) to another given ability (say to do them in 25 minutes with 10 errors). That is, there might be identity in the rate of change in improvement amongst individuals whose total improvement was identical, so that significance attaches to the answer to the following hypothetical question:

Considering the changes in the rate of improvement from any one given degree of ability to any other given degree of ability to be due to one general law of change of rate plus individual deviations from it due to internal and external disturbing factors, what is this general law of change of rate?

This general law for the case of progress from a score of 4,000 to a score of 2,000 for ten examples is approximately that given by the dotted line of Fig. 2. It is obtained by taking the individuals[1] who, in some succession of tens of their practice, progressed from 4,000 or more to 2,000 or better, and plotting for each a curve irrespective of the *amount* of practice that carried them from a 4,000 score to a 2,000 score. The curves, that is, all start at 4,000, all end at 2,000, and all occupy the same length of the abscissa, so that they vary in the one element of the rate of change of improvement. The dotted line of Fig. 2 represents the one such curve from which the separate curves could be derived with the least improbability.

The reader will understand that the writer does not attempt to decide whether there is, for either case, any such one general law. As was stated on a previous page, three place mental multiplication is not a specially favorable case to study the issue and the measurement of the influence of external factors could not, in the present study, be made satisfactorily. So far as the evidence does go, it favors the conclusion that the differences amongst individuals in the changes in rate of improvement are due not only to the influence of one same law plus differences in conditions, but also to the action of radically different laws acting on different individuals according to the different physiological changes in them to which the improvement is due. The curves of Fig. 2 would then be mongrels representing no significant laws of nature.

The Influence of Equal Practice upon Individual Differences

Experiments in practice offer evidence concerning the relative importance of original nature and training in determining achievement. In so far as the differences amongst individuals in the ability at the start of the experiment are due to differences of training, they should be reduced by further training given in equal measure to all the individuals. If, on the

[1] In this case two individuals not in the 28 were included since the completion of the entire 96 examples is here irrelevant.

contrary, in spite of equal training the differences amongst individuals remain as large as ever, they are to be attributed to differences in original capacity.

As a matter of fact in this experiment the larger individual differences *increase* with equal training, showing a positive correlation of high initial ability with ability to profit by training. The data are given in Table II.

TABLE II

The ratios of the worse to the better records, early and late in the course of practice.

The numbers 1 to 28 refer to the records in order of excellence, the same number thus possibly meaning different individuals.

Records Compared	For First 5 Examples	For First 10 Examples	For Second 10 Examples	For Ninth 10 Examples	For Eighth 10 Examples	For Last 5 Examples	Relation of late to early variability, by different measures of it
21/8	1.73	1.68	1.61	1.44	1.42	1.41	Less
22/7	1.93	1.88	1.71	1.57	1.49	1.60	Less
23/6	2.21	2.04	1.92	1.78	1.59	1.95	Less
24/5	2.32	2.36	2.08	2.25	2.70	2.81	Greater
25/4	2.44	2.59	2.31	2.84	3.76	3.18	Greater
26/3	3.00	2.83	2.44	3.27	4.07	3.48	Greater
27/2	3.36	3.29	3.53	3.66	4.48	4.58	Greater
28/1	5.60	4.01	3.85	5.02	4.58	5.61	Greater

It is impossible as yet to demonstrate how far this influence of equal practice extends amongst the important mental functions, partly because common life does not make the experiment of equal practice often enough for us, and partly because comparable units for the measurement of mental achievement are so often lacking. To the author the achievements of students in schools and colleges seem to show in general that the greater original capacity gains as much or more from the same environmental training, and the differences amongst individuals who have all been brought practically to their physiological limit in the case of speed of reading, musical technique, ability in science or business or the like seem to be in general greater than the differences amongst the same individuals at earlier equivalent stages in practice. Moreover, it seems extremely probable from many facts of dynamic psychology that the man who has the capacity to improve to a given small degree more quickly than another should also improve more quickly to the next degree and should also, by and by, be capable of improving to a higher degree if given the maximum of efficient training.

THE PROBLEM OF FATIGUE.

By William H. Burnham.

Hygiene is sometimes called the science of the future. Perhaps the same is true of psychology. However that may be, its doctrines at the present time are largely in the form of problems. This is encouraging; for in the field of science a definite ignorance is the beginning of wisdom.

The whole subject of work and fatigue among school children has been studied by many investigators for twenty years or more, and the outcome of it all is a series of tolerably definite problems. The general problem of fatigue involves, on the one hand, many physical factors, on the other hand, many psychological factors, and also the relation of these two sets of factors. The relation of fatigue to the various psychic factors, —such as practice, warming up, habituation, voluntary effort, and the like, has been carefully studied by Kraepelin (8) and the complexity of the problem has been well shown by Dr. Bolton. (2.)

From the physiological side the problem of work and of fatigue has thus far been treated by most writers as if the human organism were practically a complicated and delicate machine whose working is affected by its environment as regards temperature, humidity, etc., by the overcoming of friction and its own inertia, by periods of rest to avoid over-heating of parts, by suitable oiling, cleaning, etc., but whose ultimate output of energy is determined by the fuel it consumes. The nervous system has been likened by Dr. Donaldson (3, p. 293) to an engine. The analogy is a good one for its purpose. But the psycho-physical mechanism has a power of adaptation not possessed by any machine. Especially is this true during the period of growth and development. Thus the problem for the work of children seems to be almost hopelessly complex, because within certain limits the power to resist fatigue can be acquired. Very likely as suggested by Weichardt's (19) investigations this is due in part to an acquired immunity to the toxic products of fatigue; but whatever the cause of it the fact seems to be shown.

The problem is still further complicated by the fact that the amount and quality of brain work that can be done is determined by many conditions. Among the most important of

these are the following: Race, sex, physiological age, food, drugs, sleep, temperature, light, air, season and meteorological conditions, exercise, posture, health conditions, refraction of the eyes, conditions of hearing, nasal breathing, and the whole mental attitude or apperception.

The problem of work and of fatigue in simple form is that of determining what periods of work and rest will enable an individual to do the maxium amount of work within the limits of health, whether the work be physical or mental.

It is not easy for an individual to settle this question for himself. For a group of individuals the problem is still more complex on account of the remarkable individual variations in ability which all investigations show, and for a group of individuals in the period of growth and development the complexity may fairly be called infinite. Nevertheless, it is a question that must be answered every day in the study and in the schoolroom, and so we cannot shirk it on account of its difficulty.

The problem presents itself in concrete form in testing a muscle or a group of muscles in the laboratory. One can determine just what rhythm and what alternation of work and rest will enable a group of muscles lifting a given weight to do the maximum amount of work. The problem here is not so simple, however, as it at first appears. One of the most striking results of the early experiments with the ergograph by Dr. Lombard (10) was the periodic recovery of the muscle. Contracting the muscles of his middle finger till it was no longer possible to lift the given weight, this investigator found that if he continued the effort, presently the muscles responded and the weight could be lifted nearly as high as before; and this loss and return of power occurred several times. This recovery Dr. Lombard likened to certain phenomena of periodicity shown in ordinary life, such as the second breath of the runner; and he attributed it to central causes. Recent experiments by Treves (16), however, indicate that this phenomenon of periodicity can be obtained by electrical stimulation of the muscles, and consequently it is referred by him to peripheral rather than central causes. It seems probable that the cause of this periodic recovery is to be found partly in the nerve centres and partly in the peripheral apparatus, that when it occurs under ordinary conditions of stimulation both central and peripheral causes combine to produce it. While Treves (16) has shown that these phenomena may be produced by peripheral stimulation alone, as Dr. Bergström (1) has said: "This does not, however, show that changes in force, even rhythmic changes, may not also occur in the nerve centres stimulating the muscle." Whether this recovery is due to central causes as supposed by Lombard (10), or to peripheral causes as maintained by Treves

(16), or partly to changes in the nerve centres and partly to changes in the periphery as suggested by Bergström (1); and whether the physiological causes are changes in nutrition, or the results of an antitoxin, or some unknown factor, the phenomenon suggests the possibility of extending the limits of the functional activity of a set of muscles and even of one's working capacity in general. But how far and in what way it may be safe to attempt this, we do not know.

At all events the factor of training must be reckoned with, and this in itself presents a very complex problem. The difference between the trained muscle and the untrained muscle is not merely a difference in size and nutrition. Professor Hough (5) has shown that in case of the untrained muscle the fribrillæ are lacerated by exercise—hence the soreness that results. In the trained muscle this tearing does not occur. Also a very complex process of adaptation or habituation is involved. To quote Dr. Bergström (1, p. 273) again: "A certain class of psychic factors certainly affect the records; competition and encouragement often greatly augment both momentary strength and endurance, and discouragement or a sense of failure may produce the contrary effect. By pretending to present a subject with a series of increasing loads, successive reductions in the record may sometimes be observed, while as a matter of fact the load remains constant. Habits of effort, like habits of sleep, may no doubt exist or be established by training, and even variations like the Lombard curves are not impossible from such a source, but might be due to overcoming a reflex tendency to rest, just as we may by persistent effort counteract a tendency to fall asleep." Even on the physical side the problem is a complex one. The problem of training is closely related to that of immunity; and it will be helpful briefly to consider the latter.

When certain poisons are introduced into the animal body, nature at once proceeds to manufacture an antidote, and if the amount of poison introduced at any one time is not too large, the antidote is usually sufficient to correct its effect. This has been illustrated very vividly in modern therapeutics.

The modern discovery of antigenes and anti-bodies has revolutionized the treatment of many diseases. Antigenes are substances of unknown chemical composition which act as stimuli for the production of anti-bodies; and anti-bodies, not to attempt a technical definition, are substances which act as antidotes to certain poisons, or as checking agents upon the antigenes. The toxin and antitoxin of diphtheria furnish the standard illustration. If the toxin of diphtheria is repeatedly injected in proper quantities into the blood of a horse, this stimulates the production of an anti-body, which can be taken from the veins

of the horse and used as a remedy. Thus is produced the antitoxin for diphtheria, which during the last dozen years has so enormously reduced the mortality from this disease.

In a similar way are produced antitoxins for a number of diseases: for tetanus, for dysentery, for the poison of snakes, etc. But it is not only in disease that such anti-bodies are produced (19), and not merely the poisons that act as antigenes in producing these bodies. Antiurease, antitrypsin, antipepsin, and the like, belong to this same group of anti-bodies occurring in the normal animal.

In tuberculosis we have an interesting illustration, apparently, of the general law of immunity. It is estimated that one-seventh of the total mortality results from this disease; but a vastly larger number have been afflicted with it. Dr. Flexner estimates that at least 90 per cent. of the total population have been subject at one time or another to tuberculosis. This has been shown by the results of innumerable autopsies. The resistance to the disease, however, is so great in most people that it has been cured or arrested. Again, the most successful experiments in the treatment of tuberculosis in animals have been those of direct inoculation with tubercle bacilli, thus developing immunity,

Acquired resistance to fatigue seems to be also a case of immunity. It was apparently proved by Mosso that toxic products result from the functional activity of the muscles and that these are the chief cause of fatigue. Thus when the blood of a tired dog was injected into the veins of a normal one the latter showed the symptoms of fatigue. If Weichardt's studies (18 and 19) are to be credited this is only half the story. His results not only corroborate Mosso's theory of a fatigue toxin, but have also shown apparently the existence of certain anti-bodies that produce an antitoxin of fatigue. From his remarkable experiments with mice this investigator reports that when a mouse was worked to exhaustion he found a toxin produced in the muscle serum. This purified from salts, creatin, urea, and albumen, and injected into another mouse caused fatigue, and in large doses death. When a horse was treated with frequent injections of this purified serum an antitoxin was formed which acted as an antidote to fatigue.

Weichardt (19) has made many experiments with this toxin and antitoxin of fatigue. With the artificially produced fatigue toxin all the characteristic symptoms of fatigue, even death from exhaustion, are produced. On the other hand, he has also succeeded in neutralizing the effect of the fatigue toxin by means of the artificially produced antitoxin.

The discovery of fatigue toxin in the excreta of the body and even in human urine shows that the formation of toxic

products occurs in ordinary physiological fatigue, and that extreme pathological fatigue is not necessary to produce this toxin. The antitoxin also, not only may be produced artificially in the manner just mentioned but is produced during normal functional activity. With the appearance of moderate quantities of the products of fatigue there always occurs in the healthy organism an increased formation of the specific antitoxin, *i. e.*, there is always the tendency to develop immunity to fatigue.

This has been shown by Weichardt (19) in his experiments with mice. The normal curve of work for a mouse is similar to that of a man as shown by the ergograph. If the mouse is treated with an injection of a moderate dose of toxin the curve of work is somewhat raised, and then sinks only slowly after a prolonged period. The reason for this is that a moderate dose of the fatigue toxin works as an antigene and produces the antitoxin in increased quantity, thus enabling the animal to do more work. If, however, the mouse is given a large dose, so that the cells which produce the antitoxin are injured, the ability to work is decreased; or, if the dose be sufficiently large, the animal soon dies from the effects of it. If, however, mice which beforehand have been treated with the antitoxin are given a large dose of toxin a continuous curve of work is produced. The curves of men, who have been trained in the use of the ergograph, correspond to the curves of mice treated with the antitoxin. Of course, the human subject cannot be treated with a large dose of the toxin; but the stages of increased ability to work, *i. e.*, the stages of active immunity brought about by the stimulus of small doses of the toxin, are shown. In other words, the process of training is not a mere process of modification and increase of muscle tissue, it is also a process of rendering the subject immune to fatigue. In the trained subject the ability to work is increased as a result of increased power to resist fatigue.

One is at first inclined to think that Weichardt's (19) study is another case to be added to the long line of discredited investigations in this field. But whether his results stand the test of further experimentation or not, the problem of fatigue is not misrepresented by them. It is in part the problem of adaptation or immunity. And for the present we may naturally conceive of this as analogous to the immunizing contest in infection as represented by the hypothesis of Dr. Welch:[1] "The struggle between the bacteria and the body cells in infections may be conceived as an immunizing contest in which each participant is stimulated by its opponent to the production of

[1] As cited by Ricketts in "Infection Immunity and Serum Therapy". Chicago, 1906, p. 567.

cytotoxins hostile to the other and thereby endeavors to make itself immune against its antagonist."

Of course, all of this applies primarily to muscular fatigue, but it is probably true that the conditions of fatigue resulting from mental activity are similar and that within certain limits immunity to fatigue may be developed, or in psychological terms, habits of increased ability to work may be formed. This was pointed out some years ago by German writers. Dr. Erb (4, pp. 26-27) for example writes:

"The nervous system in its comprehensive mode of habit and adaptation is capable of increased exertions as well as able to endure greater injuries, as von Ziemssen recently has shown in an interesting manner. . . . Just as our senses become accustomed to all possible impressions so that they pass almost unnoticed, so also the brain will gradually learn to accustom itself to all the daily injuries which beset it, to the noise, the hurry, and unrest, the mechanical shocks in our everyday life and business. It will be more difficult to be sure with the psychic shocks, the excitements and emotions, but even here, habit, training of character, and self-control can certainly do very much; and thus we have good prospect that our nervous system will adapt itself, to a certain degree, to the demands placed upon it by our culture of to-day and by habituation neutralize their injurious effects."

The relation of the mental factor to fatigue likewise presents a very complex problem. It has been briefly stated by Dr. Seashore as: "The correlation of psychological and underlying factors, such as physical, chemical, histological, and electrical phenomena. If the attention wave varies with fatigue, as Prof. Pillsbury has demonstrated, we may ask, what are the physiological factors which condition that variation? What feature in the mental work is it that causes the physiological state? What chemical processes may be traced? What is the cell modification? Are there any characteristic electrical variations?"

Again we have the great problem of the relation of one kind of fatigue to another and whether there is one reservoir of energy or several. It has frequently been noted that change of occupation is a means of rest. The child tired with school work turns with enthusiasm to his play; and even a game requiring close attention or an interesting book is taken up with a zest which indicates that the interesting occupation is rest from the routine of study; and the man of business weary with the work of the day turns at night to the study of some engrossing fad and finds it a means of rest and recreation. Mosso (11, p. 120) in his book on fatigue says: "Apparently the fatigue is localized only in a certain region of the brain; for one often sees

persons who have become incapable of thinking about a certain subject or considering a matter of business find recreation in thinking of something quite different, or even rid themselves of a feeling of pressure in the head by turning their attention sharply to other things of a different character, for example, to chess playing."

Weygandt (20) working in Kraepelin's laboratory, has studied this question. His problem was this: does change have a favorable or unfavorable effect upon the amount of work done? He employed Kraepelin's method of adding varied with several other forms of activity,—learning by heart of numbers and nonsense syllables, the search for a definite letter in a connected text, reading of a foreign text of different kinds, —Latin, Italian, Hungarian, Hebrew, the writing down of a known series of letters, and finally, a series of experiments with complete pauses instead of change of work. Almost all these methods were used for the chief work as well as for the change of work. Of the different methods, adding predominately appeals to the associative processes; the learning of numbers and syllables to memory; the reading methods involve perception and assimilation. First, he worked for one day at a definite form of activity for one hour and a quarter; then on the next day he worked for the first half-hour at the same form of activity, this determining the character of the day's work; then followed a change taking up another definite activity, for half an hour; then again for fifteen minutes he worked at the original activity to determine the effect of a change on the amount of work done. These experiments extended over some 97 days of experiment, the usual control of conditions being adopted.

As a result of these experiments, it appears that change of the method of work is not under all circumstances favorable. Often the result is positive, often negative, but usually only very slight. Second, the difficulty of the work appeared as a determining factor in the result. A form of work broken by a more difficult form of work shows thereafter less results than would be expected; broken by a lighter form of work, on the other hand, shows better results. Third, it is all the same whether the mental work that alternates with another is of similar or dissimilar character. In a word, the result of his investigation furnishes no evidence for the assumption of a partial and localized mental fatigue. And Kraepelin (8) interprets his results as indicating that fatigue is general. "Fatigue through mental work is," he writes, "so far as we know, a general fatigue. As especially Weygandt's study on the effect of change in mental work has shown, the fatigue through a particular activity also reduces the capacity for such work as is brought about

through quite different mental activities. Thus the necessity of rest and sleep arises at certain times regardless of whether the same or changing work has provoked it. Only the difficulty and not the kind of mental work is significant for the general extent of fatigue."

Dr. Seashore thinks that Kraepelin is wrong in this and he reports experiments in Iowa laboratories that have demonstrated that the kind and degree of fatigue both depend upon the kind as well as the degree of mental exertion. It seems to be still a problem whether there is one reservoir of nervous energy or many reservoirs, or in other words whether fatigue is always general fatigue, one and the same, or whether it is often local fatigue. There is some reason for believing that there may be a difference between children and adults in this respect, one reservoir representing more nearly the fact for the unorganized system of childhood.

It would seem at least that the popular idea that change of work means rest, and the pedagogical maxim emphasized by Richter (13) as the result of his experiments with school children in occupations similar to those of the ordinary school work, must be modified. The fact probably is that in the more ordinary cases it is not fatigue which is appreciably lessened by change of work but rather the feeling of boredom, the ennui, the *Müdigkeit* not the *Ermüdung*, as Kraepelin (8) distinguishes the two. In the more extreme cases, as illustrated in the case of the exhausted soldier who arouses himself to renewed activity in a crisis, or the experimenter in the laboratory who exhibits the phenomena of recovery, or the runner who gets his second breath,—what happens is probably that a new store of energy is in some way set free; and, although the feeling of fatigue has disappeared, fatigue itself may have been increased and the ultimate ability of the organism to work diminished. But definite results are lacking and more experimentation is needed.

Professor James (6) has recently studied many of the phenomena similar to those of second breath, and concludes that our organism "has stored up reserves of energy that are ordinarily not called upon, but that they may be called upon: deeper and deeper strata of combustible or explosible material, discontinously arranged, but ready for use by any one who probes so deep, and repairing themselves by rest as well as do the superficial strata. Most of us continue living unnecessarily near our surface."

He reports many interesting cases where old habits of performance have been broken up and an astonishingly increased capacity for work developed. Among the dynamogenic agents that he has studied are the training of the Yoga system, Christian Science, and the like, religious, political, philo-

sophical, and scientific conversions, and among more concrete energy releasing ideas, "Fatherland," "the flag," "the Union," "Holy Church," "the Monroe Doctrine," "Truth," "Science," "Liberty," Garibaldi's phrase "Rome or Death," etc.

This investigation opens the deeper problems of neural economy. That there are many such cases as those cited by Dr. James (6) cannot be doubted. Further study may show that such cases fall into widely different classes. Some of these are probably pathological. An abnormal activity is aroused, the subject may perhaps kill himself or become a wreck in a few years. Most of them, however, are perhaps normal and, as suggested by Professor James (6), they frequently represent the cure of nervous disorder. In some cases the great improvement in the individual's productive activity may be brought about merely by stopping waste. It is astonishing how much this amounts to in the case of many persons. Every one in his experience has the opportunity to note the great economy of co-ordinated activity and the extreme waste when confused, or nervous, or "rattled." Some persons work without waste excluding all interference of association and all unessential movements when under pressure. Others are made nervous by undue pressure and work most economically when at leisure. When hard pressed they are nervous and confused, when at ease they make no false motions, have no interference of association, and work directly and economically. In both classes the great improvement in productive activity is brought about by the same means, namely, the stopping of waste.

In other cases the great improvement in productive activity may be due to an improvement in nutrition, more energy is stored up, and thus the amount of energy available for work is increased. This improvement may be brought about in two ways: First, the checking of worry and habits of emotional prodigality by working under a strong stimulus is quite enough in many cases greatly to modify and improve, it may be, all the nutritive functions of the body; and this in some cases may be the chief factor.

Again, the nutrition may be greatly improved perhaps in a very different way. It seems probable that the nervous system functions rhythmically; first, a period for the storing up of energy, a period when the anabolic processes predominate; then a period of explosion when the katabolic processes predominate, and so on. Now as is generally recognized a suitable period for the storing of energy is essential in order to give the necessary conditions for the vigorous explosion of energy. It is probably also true, although this seems to have been neglected, that the vigorous explosion of energy is likewise a necessary condition for the proper functioning of the anabolic

processes that predominate in a subsequent period of rest. Verworn's (17) hypothesis that after exercise there is not only the restoration of what has been lost but an over-compensation is in harmony with this view.

Thus in some cases the improvement in nutrition is probably caused by the fact that the vigorous explosion of energy due to a strong stimulus has furnished the one essential condition for the functioning of the nutritive processes on a higher level. Thus in certain conditions excitement and the explosion of energy may be as essential as rest and the storing of energy.

Again, this theory is in harmony with the results found by Professor Patrick (12) in his study of sleep, referred to by Dr. James (6). After one subject had been kept awake for over 90 hours, 13 hours of sleep seemed to be enough to restore him to normal condition. This was explained in part by Professor Patrick on the theory that the rate of repair was increased, the anabolic processes were so stimulated that the short period of sleep was all that was needed. In these experiments the essential condition of the increased nutrition seemed to be the increased expenditure that had preceded. In ordinary sleep also we have an illustration of the same phenomenon. Frequently the condition of sound and refreshing sleep seems to be the normal exhaustion that results from vigorous activity during the day, a fact that has been observed since the days of Solomon: "The sleep of a laboring man is sweet whether he eat little or much."

Another factor which probably accounts for some of the increase of work in such cases is the development of immunity to fatigue, perhaps to the toxic products of fatigue, as suggested by Weichardt's (19) experiments.

In certain instances, perhaps in most, all of these factors combine to produce the increased efficiency of work. In most of the cases probably a better habit of functioning is the secret, but this involves better nutrition and very likely the acquisition of immunity.

The study of the neurasthenic is instructive. The characteristic symptoms are too familiar. They are chronic fatigue, inability to perform any continuous task, lack of energy for any vigorous action, and also irritability, restlessness and a continuous dribbling out of energy. If the hypothesis already suggested be true, then this condition may be due to any one of three causes.

First. The individual may never have developed any considerable amount of nervous energy. He may be one of those, as suggested by Tissié (15), who are born in a condition of fatigue. The nervous system may be undeveloped so far as its trophic functions are concerned.

Second. The individual may have a nervous system that is normal, but may never have been stimulated to any vigorous explosion of energy, consequently a necessary condition for the proper storage of energy is lacking. Such probably, as already suggested, are some of the cases cited by Dr. James (6), and the remarkable results of the Yoga system, the emotional stress of conversion, or of falling in love, or what not, are due to the fact that thus a vigorous expenditure of energy was caused and this provided the one essential condition lacking for the normal storing of energy. In such cases we may conclude that a strong stimulus or shock of some kind is the thing needed.

Third. In another class of cases the individual has seriously over-taxed himself. The nerve cells have perhaps actually been injured so that normal recovery is temporarily at least impossible. In such cases what is needed first of all is rest. To ignore this condition and attempt to cure by further work, by greater stimuli and the like, would be useless and perhaps fatal.

We are not concerned here directly with the practical questions of therapeutics, but we note that we may have practically the same symptoms with patients of very different nervous conditions and requiring diverse treatment. The practical problem of diagnosis in such cases is no more complex than the hygienic and economic problem of determining the proper quantity and quality of activity. One must know the condition of an individual's nervous system if one is to prescribe a method of work.

Thus the problem of tapping the deeper levels of energy involves the problems of nutrition, of physical and mental adaptation, and of immunity.

Among other important questions which still remain open in this field, are the following:

First. Although it has been shown that certain phenomena like periodicity may be brought about by peripheral causes alone, the question is still unsettled whether the fatigue resulting from ordinary neuro-muscular work is primarily central or peripheral.

Second. It does not seem to be as yet satisfactorily settled whether the nerve centre or the periphery is better able to resist fatigue, although it seems probable that the nerve centre has greater resistance.

Mlle. Joteyko (7) infers from her experiments that there is a hierarchy in the tissues as regards their resistance to fatigue. The nerve trunks appear to have greater resistance according to the experiments of a number of writers. According to Mlle. Joteyko's (7) experiments the reflex centres of the cord

have greater power of resistance to fatigue than the psychomotor centres, and both have greater resistance than the peripheral apparatus. Thus she concludes that in physiological conditions the phenomena of motor fatigue are due to the arrest of function of the intra-muscular nerve endings.

Thus Mlle. Joteyko (7) thinks that she has shown that the origin of fatigue is in the main peripheral and that fatigue plays a kine-philetic rôle, that is, it is a defensive function of movement. One feels inclined to accept the results of this brilliant experimenter; but further investigation of this point is desirable.

Third. The question of the range of individual variation in ability to work and to resist fatigue, and of types of workers, and the like, is suggested as an important one by the studies of Kraepelin (8) and Mlle. Joteyko (7).

Fourth. The problem still remains of finding a good practical test of the psychophysic condition of an individual that can be used by a teacher or a physician to determine whether one is overworked or not. Perhaps it is too much to expect that any simple test of a condition so complex will ever be possible.

Thus the whole problem of fatigue is an infinitely complex one. We are not concerned here with practical inferences from the investigations that have been made. We may add a few words, however, in regard to the relation of the problem to pedagogy. With our present knowledge it is impossible to give an adequate solution of the practical questions involved. One general point, however, is emphasized by the results of these investigations. Immunity to the toxic products of fatigue is probably brought about by gradual habituation to small doses of fatigue toxin. Large doses decrease the ability to work and may do permanent injury. Thus it would seem that the general rule of hygiene is established in correspondence with that resulting from ordinary observation, that the way to develop power to resist fatigue in children is by short periods of intense work followed by periods of rest rather than by prolonged periods of work; and in fact that the latter should be looked upon with grave suspicion as likely permanently to injure the ability to work.

This inference is largely in harmony with the suggestions that come from the observation of cases of the character reported by Dr. James (6). As he suggests from a very different point of view habit and adaptation in conflict with the excitement of emotion are determining factors. "The emotions and excitements due to usual situations are the usual inciters of the will. But these act discontinuously; and in the intervals the shallower levels of life tend to close in and shut

us off. Accordingly the best practical knowers of the human soul have invented the thing known as methodical ascetic discipline to keep the deeper levels constantly in reach. Beginning with easy tasks, passing to harder ones, and exercising day by day, it is, I believe, admitted that disciples of asceticism can reach very high levels of freedom and power of will."

The concrete problems of the schoolroom related to the general problem of fatigue are legion. Teachers may naturally be sceptical of any attempt to solve them by scientific methods. Dr. Lehmann (9, p. 297), a gymnasium teacher, for example writes:

"An exact theory of instruction or of its separate factors of the programme, for example, is impossible because the practical work of teaching must every moment reckon with forces which experiment can neither exclude nor estimate. The pupils are not even for a moment merely heads with the angel wings of the intellect. The personality of the teacher, for example, and the relation of the pupils to him constantly influences the tension and the kind of association of the class. There are not only teachers who fatigue their pupils quicker than others, but also those whose force of suggestion holds them quite in their own power and causes them to overcome fatigue for a relatively long time. But if one seeks to estimate the personality of the individual teacher or the character of the pupils by making the experiment with a very large number and accordingly gets very large figures, the results obtained may still be of value for theoretical psychology, but for pedagogy and for the practical work of instruction they are worthless."

While this distinguished German teacher is right that no exact rules can be developed in this field, he is not to be understood as deprecating the scientific study of the conditions of school work. And probably the value of such study in emphasizing the complexity of the problem, in making definite the knowledge we already have, and in mediating between conflicting opinions, will amply reward investigation. Moreover, in such problems we cannot expect exact information, but the writer believes that more definite practical contributions than most teachers imagine are possible.

At present we are just beginning to see the complexity and the significance of the concrete problems of economy and hygiene in school work. Questions of physiological age, seasonal variation in growth and energy, individual variations in ability to work and to resist fatigue, the conditions of training and of immunity, of sanitary and of social environment, are all involved; and many special studies must be made before definite rules for the optimum conditions of school work can be formulated. And until further investigations have been made

have greater power of resistance to fatigue than the psychomotor centres, and both have greater resistance than the peripheral apparatus. Thus she concludes that in physiological conditions the phenomena of motor fatigue are due to the arrest of function of the intra-muscular nerve endings.

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us off. Accordingly the best practical knowers of the human soul have invented the thing known as methodical ascetic discipline to keep the deeper levels constantly in reach. Beginning with easy tasks, passing to harder ones, and exercising day by day, it is, I believe, admitted that disciples of asceticism can reach very high levels of freedom and power of will."

The concrete problems of the schoolroom related to the general problem of fatigue are legion. Teachers may naturally be sceptical of any attempt to solve them by scientific methods. Dr. Lehmann (9, p. 297), a gymnasium teacher, for example writes:

"An exact theory of instruction or of its separate factors of the programme, for example, is impossible because the practical work of teaching must every moment reckon with forces which experiment can neither exclude nor estimate. The pupils are not even for a moment merely heads with the angel wings of the intellect. The personality of the teacher, for example, and the relation of the pupils to him constantly influences the tension and the kind of association of the class. There are not only teachers who fatigue their pupils quicker than others, but also those whose force of suggestion holds them quite in their own power and causes them to overcome fatigue for a relatively long time. But if one seeks to estimate the personality of the individual teacher or the character of the pupils by making the experiment with a very large number and accordingly gets very large figures, the results obtained may still be of value for theoretical psychology, but for pedagogy and for the practical work of instruction they are worthless."

While this distinguished German teacher is right that no exact rules can be developed in this field, he is not to be understood as deprecating the scientific study of the conditions of school work. And probably the value of such study in emphasizing the complexity of the problem, in making definite the knowledge we already have, and in mediating between conflicting opinions, will amply reward investigation. Moreover, in such problems we cannot expect exact information, but the writer believes that more definite practical contributions than most teachers imagine are possible.

At present we are just beginning to see the complexity and the significance of the concrete problems of economy and hygiene in school work. Questions of physiological age, seasonal variation in growth and energy, individual variations in ability to work and to resist fatigue, the conditions of training and of immunity, of sanitary and of social environment, are all involved; and many special studies must be made before definite rules for the optimum conditions of school work can be formulated. And until further investigations have been made

it appears desirable that the practical questions in regard to the period of study, and the like, be solved tentatively, and that different plans be tried experimentally to the end that ultimately a solution based upon scientific data may be obtained.

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PSYCHOLOGICAL LITERATURE.

Essays Philosophical and Psychological: in Honor of William James. By his Colleagues at Columbia University. New York, Longmans, Green & Co., 1908. pp. viii, 610.

This handsomely appointed volume—generous in bulk, but refreshingly light in the hand—contains a series of nineteen essays, classified by the editors as philosophical and psychological, which have been written in honor of Professor James and pragmatism by present or recent members of the Departments of Philosophy and Psychology at Columbia University. An excellent portrait of Professor James serves as frontispiece.

The philosophical essays, which we can here only enumerate, are as follows: "The New Realism," by G. S. Fullerton; "Does Reality Possess Practical Character?" by J. Dewey; "A Factor in the Genesis of Idealism," by W. T. Bush; "Consciousness a Form of Energy," by W. P. Montague; "Perception and Epistemology," by F. J. E. Woodbridge; "Substitutionalism," by C. A. Strong; "World-Pictures," by W. B. Pitkin; "Naïve Realism: What Is It?" by D. S. Miller; "Kant and the English Platonists," by A. O. Lovejoy; "A Critique of Kant's Ethics," by F. Adler (reprinted from *Mind*, April, 1902); "The Abuse of Abstraction in Ethics," by H. G. Lord; "Purposive Consistency, the Outline of a Classification of Values," by G. A. Tawney; "The Problem of Method in Mathematics and Philosophy," by H. C. Brown. As will be seen from the titles, and as appears from the contents, these papers have fully as much to do with metapsychology as with metaphysics: a natural and fitting state of affairs, in view of the purpose of the book. As is also natural, seeing that (with the one exception noted above) they have been prepared in the course of a single year, the essays are of very various degrees of merit, ranging from the occasional contribution to systematic and historical investigation of permanent value.

The first of the psychological essays, by K. Gordon, deals with "Pragmatism in Æsthetics." Pragmatism is the disposition to look for final explanations in terms of purpose, and for reality in experienced satisfactions. Approaching æsthetics from this point of view, Miss Gordon finds that the motive of the artist is to "impose his experience on others," "to establish and preserve whatever novel emotions or supreme moments his experience may have held." "The work of the artist is to objectify new or striking emotions;" "there is always a social reference in this desire for expression." Passing from artist to admirer of art, she discovers "the characteristics of the æsthetic consciousness" in "a remoteness from immediate self interests, a suggestible and imitative attitude towards the object, and an allegiance to a reality felt to be independent of oneself." Behind all this, the keynote to the consciousness both of artist and of observer is "an instinct for excitement, a curiosity about the untried, and a liking for whatever is novel and stirring." Finally, the art-product has to be explained, as middle term between producer and admirer. Individually, emotion arises from conflict of impulses; "the objectification of emotion is an objectification of conflict, and whoever preserves an emotion preserves an ungratified impulse, a problem unsolved or a

purpose unfulfilled." Socially, the function of art is originally instrumental, "not so much a stilling as a prodding of the will." Modern art is also instrumental, only that it stimulates not to a specific but to a generic act, "and leaves each individual to live out for himself the meaning and the end of it." The term 'disinterestedness' is misleading; only some interests, by no means all, are in abeyance in æsthetic contemplation. The æsthetic moment derives its value from a purpose, and is not literally 'free from desire.' The feeling of freedom derives from the nature of emotion, as representing a choice of possible action. Art, in a word, "preserves and presents meanings at their emotional stage, before they have become explicit, definite, or solved." As stimulative and instrumental, it is "prior to that which it effects. Life and nature are in a vital sense experienced as products of art."

We have given the above summary so far as possible in the author's own words, because the paper is merely an outline sketch of a comprehensive theory. How stable that theory would prove to be, if fully worked out, we do not know. Obvious points of criticism are: the total neglect of the technical motive in æsthetic production; the psychological account of such an emotion as anger as a 'conflict of impulses'; the over-direct passage from genesis to analysis, from the question of origins to the function of art in modern society; the extreme poverty and the personally motived selection of the illustrations; and the casual and, so to say, contextless reference to other theories. It is only fair to add that some of these defects are rendered inevitable by the limits of the paper. Others, however, are not.

The next paper, by R. S. Woodworth, on "The Consciousness of Relation," falls into line with a fairly long series of recent psychological investigations, a series that extends from Marbe and Ach to Bühler. It deals with one phase of a problem which appears elsewhere as that of the 'general attributes of sensation' (Ebbinghaus), of *Bewusstheit*, *Bewusstseinslage*, *Gedankenelement*, or again, in other connections, as that of *Gestaltqualität*, *Bekanntheitsqualität*, *Wirkungsakzent*, etc. Professor Woodworth makes no reference to previous wrokers at this and at cognate problems, even in a footnote. His thesis is, in general, that there are, "in thinking, moments bare of recognizable imagery, containing no sensations of interest — moments, nevertheless, of mental alertness and of keen consciousness," and that "it is ultra-parsimonious for the psychologist to try to keep house without these facts." More particularly, he argues for the existence and the qualitative simplicity of 'feelings of relationship,'— quoting here James's "Stream of Thought," but not quoting Herbert Spencer or Schrader. The logical bifurcation of a relation presents no difficulty either to psychology or to brain physiology. Logical complication is not paralleled by introspective complexity: "a relation may be of any order or power, and still have in consciousness a felt quality which is equally simple." Relations are, in reality, no more 'private' or incommunicable than are sensory qualities. While, however, all science deals with relations, and these or the adjustments to them carry thought forward, "the utility of the *feelings* of relation is by no means evident." Still, we cannot either say what is the utility of the particular sense-qualities; so that the aporia is, at least, old and familiar.

In comment upon this position, it may be remarked that there will always be, in a growing science, two types of workers, those who prefer to work within fields and by methods that have already proved fruitful, and those who are impatient of restriction and tend naturally to the unexplored and undiscussed. The besetting sin of the former is

overhasty and overstrict systematization. The besetting sin of the latter is incomplete and loose-ended observation, and consequent unfounded generalization. Each type must keep critical watch upon the other, but each must also try to sympathize with the other's point of view. There is, now, no doubt as to the facts to which Professor Woodworth and psychologists of his kidney appeal; the question at issue is a question of interpretation. Is 'imageless thought,' *Bewusstseinslage*, a complex of residua of images of the higher senses, of organic nascencies, of verbal short-cuts, of psychophysical sets and dispositions,—or are we in presence of what Titchener would call a structural element of consciousness? Very similar questions are to be met with in the current psychology of feeling; and there, as here, positive answer is impossible. Conservatism, however, would seem to be indicated. Let us remember, for example, how insistently the moralists have urged that conscience is a unique and irreducible mental phenomenon, and how successfully psychology has held out against the claim. Let us remember that every content of consciousness is, in a certain sense, unique and simple; my idea of the cosmos is, in a way, as unanalyzable as Professor Woodworth's 'sky-scraper' of piled relations. As reproductive unit, as vehicle of a single meaning, every idea is thus simple. Let us remember, too, the errors into which the psychologists of associationism were led by their translation of unitary reproductive function into structural simplicity. And let us remember, finally, that the establishment of a novel element of mind must be a matter of extreme methodical care, and that 'rule of three' introspections—valuable enough in themselves, as roughly mapping out the territory to be explored—cannot at all be considered as demonstrative. The fields of belief, of desire, of imagination, of volition, of thought have as yet been very inadequately surveyed by experimental means. Pioneer work is necessary and welcome; but the pioneer results must be taken for what they are, gross and tentative only; to set them by the side of verified analytical data would be illogical, as well as historically unjustifiable. Grateful for the discoveries made, we must suspend judgment upon their ultimate character. As to Professor Woodworth's appeal to cerebral physiology, that seems to us to lead nowhere. We know so little of the psychophysical processes that all sorts of constructions are possible, and all must remain unconvincing.

The next two papers, those on the Variability of Individual Judgment by F. L. Wells and on the Validity of Judgments of Character by N. Norsworthy, are of a statistical character. Dr. Wells has studied "the variability in three classes of judgment; first, the highly subjective feeling of preference for different sorts of pictures [we may interject here that Dr. Wells is not the psychological discoverer of the souvenir postal card]; second, the more objective judgment of color differences, and, finally, a type of judgment whose accuracy could be readily measured by objective means. It has appeared that in the first class the judgments of each individual cluster about a mean which is true for that individual only, and which varies from that of any other individual more than twice as much as its own judgments vary from it; that in the second class, with the colors, the variability of the successive judgments and those by different individuals markedly approached each other, but still preserved a significant difference; while in the third class, with the weights, we found that there might be even an excess of the individual variability over the 'social.' This comparison seems to afford, to a certain extent, a quantitative criterion of the subjective." Further, there appears in objective fields a phenomenon of individual tendency, of 'sensation habit,' which

needs further and special investigation. Miss Norsworthy shows first that, given impartiality of the group of judges (to be attained, practically, by random selection among the competent and trained), judgments of character have objective validity. More than that, the order of excellence in the various traits estimated is, within wide limits, reliable. These results suggest the question whether the ability to judge character is itself a measurable power; the answer is, roughly, in the affirmative. The author finds, also, that there are persons about whose character there is much greater difference of opinion than is the case with others, and that, similarly, there are traits about which there is less agreement than is the case with others. Unfortunately, there is most divergence (among the traits examined) in the judgments of integrity, kindliness and refinement,—the very points upon which emphasis is laid in the employment-blanks of the educational agencies.

The fifth essay, by J. McK. Cattell, is entitled "Reactions and Perceptions." Professor Cattell argues that the 'force and liveliness' of the perception as compared with the image or idea depend upon the greater prevalence and definiteness of the motor elements. "Images and perceptions are equally the result of brain changes, which are themselves part of the world's material system. But the brain changes which are excited from within are less likely to result in motor discharges than those which form parts of sensori-motor arcs. This is necessary if the organism is to survive and prosper." In general, "the character and validity of our perceptions are prescribed by the motor responses no less than by the incoming currents." These responses may be inhibitions, which "are as integral parts of the motor processes as discharges;" "consciousness is related to inhibition in a peculiarly intimate fashion." Sight and kinæsthesis are mainly responsible for our material and spatial world. In sight, the movements of eyes, head and body are of extreme importance. In kinæsthesis it is difficult to distinguish between image and actual movement or partial inhibition of movement. This difficulty of discrimination supports the view that in vision and audition it is the motor element that differentiates perception from idea. As "the incoming currents and the discharges which lead to definite muscular reactions give reality to the perceptions", so "the incoming currents and the discharges to the inner organs with the vaguer muscular contractions give rise to the emotions." Images and perceptions are confused only when the motor reactions are confused, when they are inhibited or are excessive.

It is not quite easy to follow Professor Cattell's argument in detail. The difference between image and perception seems, on the whole, to be a matter only of degree; the "more pronounced motor elements" in perception correspond to a "superior" vividness. But, if this is the case, why is it "only a mad cat that may jump at an imaginary mouse?" Why should not a perfectly sane cat jump a little way towards the imaginary mouse, and jump all the way towards a seen mouse? The cat appears to find a difference in kind, even in Professor Cattell's pages; for the muscular tension that it shows while watching for its prey is explicitly referred to "the vivid *perception* of the approaching mouse." (For 'approaching mouse' we may here probably read 'mouse-hole' or 'smell of mouse'.) And there is another difficulty. Incoming currents are said to "arouse the suitable responses." And centrally excited processes cannot excite the same responses as peripherally excited, since "in that case the animal would not survive." This, however, is a teleological, not a causal argument. How does the hitching-on of the suitable responses take place? If, as Pro-

fessor Cattell implies, the image and the perception would be identical but for the difference in motor elements, the incoming processes must be transferred to motor paths from the same sensory centre. How does this centre discriminate the centrally from the peripherally aroused excitations? Not, of course, by any psychological equivalent of their vividness, for the difference of vividness is produced by the difference of motor elements: how then? Professor Cattell's theory can hardly be regarded as complete until an answer to this question is forthcoming. Apart, however, from these and other points of detail, the importance of the paper appears to lie in the writer's modification of the dynamogenic theory of consciousness. If he does not deny outright the statement that "all consciousness is motor," he at least makes the image-consciousness so little motor that motor reactions of the ordinary type render it abnormal, and its bearer incapable of survival. This is welcome recognition of the restricted sphere of the motor element in the mental life, and of the modest place that is accordingly to be assigned to it in psychological theory.

The concluding essay of the volume, by E. L. Thorndike, proposes a Pragmatic Substitute for Free Will. Professor James has said that the only issue of consequence in the free-will controversy is meliorism, for which indeterminism gives possibility. Professor Thorndike seeks to show that the "natural constitution of the world makes meliorism possible and, in fact, necessary." While compatible with indeterminism, meliorism is also compatible with, and even assured by, a scientific determinism.

The first and most essential part of the argument is the proof that "the behavior of a man to the same situation becomes, as a rule, more and more productive of the satisfying and less of the discomforting as the situation recurs." Ordinarily, this proposition is taken for granted. The physiological mechanism is, however, not easy to understand; and as the whole fate of scientific meliorism hinges on it (the success of individual men implying, as will be later shown, an increase in satisfaction for the whole contemporaneous group), the author works out a hypothetical mechanism, in terms of the neurone theory. This he illustrates by reference to concrete cases, and compares with the simpler mechanism proposed by Jennings. He then passes to the second stage of the argument: the proof that "behavior in favor of the satisfying to an individual leads to meliorism for the species." The lines of proof are two: "behavior not only changes itself for the better for the same situation, but also changes the situations themselves for the better for the same organism;" and, on the whole, what satisfies temporarily is satisfying for the individual's entire after-life,—temporary satisfaction being further regulated by the prescience of intellect. On both counts, the individual's gain through behavior involves no counterbalancing loss to the species. For what is good for him, as a total life, is more often than not good for the species; and, in addition, the species itself has power to weight the satisfyingness of affairs. "When behavior arises which, besides satisfying the individual, adds to the sum of satisfaction of the group, it is almost inevitably selected for survival;" care of offspring, for instance, or good will to fellows of the same species, or industry, or intellectual curiosity and its sequents, scientific investigation and invention, or the sense of justice. "Each succeeding generation's happiness is protected"—not perfectly, rather in a restricted, hand-to-mouth way; but still protected—by these modes of behavior; "and the future generation is always there to protect itself." This meliorism is intelligible; if restricted, it is a doctrine of surety; it is independent of any theory of the interrelation of mind and body; it

applies to thought as well as to conduct; it is matter of observed scientific fact. "To assert that, so far as man's own behavior goes he betters himself, is the same variety of judgment as to say that so far as the behavior of the population of Russia goes it increases itself."

The latter portion of the essay appears to us to contain little more than the generalizations natural to a writer of optimistic temperament. The nerve of Professor Thorndike's contribution lies in his attempt to substitute a workable physiological mechanism, an interplay of cause and effect, for the facile teleology of Spencer and his followers. That the mechanism is hypothetical is no objection; so far as our knowledge goes the nervous system may very well, as the author says, "be so constituted as to produce increasingly those neural arrangements which possess satisfyingness;" and no one can do more than guess at what really happens within it. The present guess was distinctly worth making, and might profitably be worked out in greater detail,— as, perhaps, it will be if Professor Thorndike's promised critique of Jennings evokes a reply. The doubt that remains is the doubt that lies behind his whole "interpretation of human and animal behavior;" the doubt of meliorism itself.

It is with regret that we note the omission of Professor Hyslop's name from the list of contributors to the volume. While, on formal grounds, Professor Hyslop would naturally be excluded from participation, his recent connection with Columbia University, and his sustained interest in matters of which Professor James is also a devoted student, suggest that a paper from his pen would have been especially welcome to the eminent psychologist and philosopher to whom the essays are dedicated. P. E. WINTER.

Die biologische Theorie der Lust und Unlust, von DR. D. C. NADEJDE. Heft I. Leipzig, W. Engelmann, 1908. pp. viii, 99.

This work represents, so far as the reviewer knows, the first serious attempt to grapple critically with the teleological—or, as the writer prefers to term it, the biological—theory of pleasure-pain. Brief critical discussions may, it is true, be found in Wundt's *Physiologische Psychologie*, in Külpe's *Grundriss*, and in Ribot's *Psychologie des sentiments;* still briefer in Ziegler's *Das Gefühl* and in Stumpf's recent paper on *Gefühlsempfindungen;* and a careful search would, no doubt, add to the list. On the whole, however, the adherents of the theory, from Aristotle down to Spencer and Lehmann, have had things very much their own way. Physiological psychology has been content to remark that the rule of correlation, of pleasure with the useful and pain with the harmful, has salieut exceptions, or that science may not lay too great stress upon a teleological maxim; it has made its formal reserves, and has then allowed the correlation to stand. A typical treatment of this sort is given, for example, in Ebbinghaus's *Grundzüge*. Such an attitude is no longer possible; all future students of the psychology of feeling must take account of Dr. Nadejde's work.

The work itself is, unfortunately, neither easy to read nor easy to review. The writer confesses, in the preface, to a certain difficulty in the use of German, and this difficulty may account for the somewhat cramped style, and the tendency to string together paragraphs whose logical connection is not always clear. Every one knows that the free and correct use of connectives is one of the supreme tests of a mastery of the German language; but we do not always realize how obscure a piece of otherwise straightforward reasoning may become if the connectives are omitted or their finer shades neglected. And the reviewer meets these further difficulties: that the critical portion of the essay

consists of detailed and highly articulated argument, while the constructive portion is couched in terms of Lipps's psychology, a psychology with a language and an attitude of its own. The author might have materially aided the reader by appending brief summaries to his several chapters; it is possible, however, that a general summary is to be included in the forthcoming Heft 2.

Dr. Nadejde begins by formulating the current teleological theory in two propositious: (1) that there is a connection between utility, or a normal mode and manifestation of life, and pleasure; and between harmfulness, or an abnormal mode and manifestation of life, and unpleasantness; and (2) that there is also a connection between pleasure and furtherance of life, and unpleasantness and hindrance of life. These two propositions, often confused, must for methodological reasons be sharply separated; the former concerns the maintenance, the latter the further advance or development of life. The present Heft 1 discusses the first correlation only. Its aim is threefold: to give a clear and comprehensive exposition of the theory itself; to furnish a detailed critique, from a strictly psychological point of view; and, finally, to reconstruct the theory in unexceptionable form.

We begin, then, with exposition, which naturally starts out from and closely follows Herbert Spencer, although other psychologists are duly referred to. Two points are of especial importance in this chapter. (1) The author brings clearly to light the twofold character of the pleasure-pain correlation. On the one hand, the feelings are regarded as symptomatic; they are signs, indications of a normal or abnormal life-mode. On the other hand, however, they have an active function; they are incentives to and deterrents from action, they guide the vital functions, they stimulate activity for ends. As symptomatic, they refer back to their cause (bodily function); as active, they refer forwards to their consequence (mental and bodily activity); there is interaction between environed organism and pleasure-pain. (2) The arguments offered in support of the theory are of two kinds: inductive and deductive. Greater emphasis is usually laid (as by Spencer) upon the deductive arguments. And these are again twofold; direct and indirect. The direct argument asserts that the biological theory is "an inevitable deduction from the hypothesis of Evolution" (Spencer); the indirect argument seeks to prove the theory by proving the inconceivability of its opposite.

The author's criticism begins with a refutation of this second, indirect proof. The refutation is flat and final. The indirect argument is guilty of two logical errors; it presupposes the very thing that is to be demonstrated, namely, the identity of utility and pleasure, harmfulness and pain; and it mistakes the meaning and nature of the law of causation. You cannot alter cause without thereby altering effect; and the existence of an "objektive Bedingung" necessarily implies the non-existence of its opposite. "It is nonsense to try to demonstrate the impossibility of the opposite of an objective condition by showing its incompatibility with other conditions; for the impossibility of the opposite is already given in its direct contradiction of actual fact, *i. e.*, of the objective condition whose opposite it is." Thus far, then, the ground is cleared.

We pass, next, to a critique of the concept of utility. This is, evidently, a concept of relation,—a *Beziehungsbegriff*, not an *Anschauungsbegriff*. So the question arises: What is the connection or relation upon which utility is dependent, or by which it is conditioned? Or, more briefly: What is the cause of the useful? When the biological theory answers this question directly, it declares: the useful is that which satisfies the needs of life, conditions the equilibrium of the

organism, etc. But such a reply is logically faulty; it explains the concepts of adaptation, normal functioning, etc., but not the concept of utility. When, on the other hand, concrete instances of the useful are given, they always take the form of certain physical conditions of life: oxygen, water, heat, nutrition, etc. And here there is a double confusion. First, the useful is identified with one set of the conditions of our physical life, and with one set only, namely, the external, environmental factors; the influence of the inner conditions, of organized substance, is left out of account. And what holds of the useful holds here also, of course, of pleasure-pain. Secondly, however, since the theory has overlooked the duality of life-conditions and has identified the useful with these conditions at large, the causal connection becomes for it not the connection of utility and pleasure, but that of physical life-conditions and pleasure. All that we have to do, then, is to strip the concept of its borrowed robes, to remember that it is the concept not of 'cause' but of 'utility,' and we see that it represents simply a subjectively conditioned judgment, of the sort with which science can have nothing to do. The concept of utility must be eliminated.

The two following chapters are occupied with the factual exceptions to the rule of correlation, and with the various attempts made to defend the theory in spite of these contradictory instances. The proposed limitations of the teleological interpretation—local, qualitative, temporal—are shown to be of no avail; and Spencer's recourse to an extension of the theory, in terms of an ethics of optimism, brings him into contradiction with his own evolutionist principles. Once more, therefore, the theory fails to meet the demands of logic. What is left of it?

We must attempt a reconstruction, bearing in mind the two cardinal errors of the biologists: the introduction of the concept of utility, with the view of discovering in the theory of feeling a basis for preconceived ethical views; and the confusion or identification of physical conditions with mental phenomena. We may say, in psychological terms, that pleasure is the expression of the direct fulfillment of the conditions, tendencies or needs of the psyche; and that unpleasantness is the expression of an imperilled or indirect fulfillment of these same conditions, etc. The symptomatic significance of the feelings is thus retained. Their active significance must be given up. For the conception of pleasure as incentive or stimulus involves the confusion, first, of feeling with active endeavor (wish, inclination), and secondly of active endeavor with movement, activity, will, *i. e.*, with the actualization of endeavor for the attainment of an end. The uniform connection between pleasure and endeavor rather finds its explanation in the law that all psychical occurrence follows the line of the easier, less resistant, and therefore free and direct realization of its natural tendencies. Pleasure is thus, in other words, an indication that the natural intrinsic tendency of mental occurrence may continue its course unimpeded by the tendency of the object which confronts consciousness; unpleasantness is an indication that the tendency of the external object impedes, inhibits, checks, obstructs this intrinsic natural tendency. Pleasure and pain are neither stimulus nor end, but symptom and symptom only.

These general remarks must now be supplemented by special considerations. First, what of the utility of pain? On the biological theory, pain must be useful, or it could not have 'survived.' Now it is not as symptom of organic damage, but rather as incentive to the avoiding reaction, that pain can be of service. And as we have seen that the active rôle attributed to the feelings depends upon a confusion

of thought, we might dismiss our question without further answer. If, however, we seek for a positive rebuttal, we find facts enough at our disposal. Unpleasant experience may be avoided not only by action but also by inaction; and the 'avoiding' reaction itself may be of two kinds, withdrawal or attack and conquest; and, yet again, unpleasant experience may be overcome, and thus in effect avoided, by habit. Moreover, the unpleasant may have to be sought, as means to a remoter end. And finally there is case upon case of inevitable pain (incurable disease), of pain whose avoidance is impossible. The biological theory breaks down.

What, secondly, of the pathological character of unpleasurable feeling? Is such feeling always a symptom of organic lack or damage? The author argues the question to a negative result in what is, to the reviewer's mind, one of the best reasoned chapters of his study. He takes up, in order, the topics of bodily discomfort (here he befogs the issue, to some extent, by a confusion of pain as feeling with pain as sensation) and of emotional or 'moral' pains and disagreeablenesses. Under the latter heading he points out, *e. g.*, that in the course of an hour's reading one may have had an almost unbroken succession of disagreements, aversions, irritations; vital disturbance, cerebral damage must, then, occur every minute or two! Moreover, it cannot be affirmed, on the other side, that pleasure means always an enhancement of life; there are pleasures from chronic indulgence, pleasures of insanity, the euphoria of the death-bed. It must, therefore, be concluded that pleasure and pain are both alike normal phenomena, and that both swing within wide limits of intensive difference.

With these special considerations out of the way, we can proceed to a final formulation. Pleasantness and unpleasantness are qualitative opposites, normal and positive experiences. Pleasantness is the symptom or index of the fact that a mental process is suited for mental assimilation; unpleasantness, on the other hand, signifies that a mental process is unsuited for mental assimilation. This conclusion is wrought out in terms of Lipps's two "fundamental conditions of the psychical life," *Vereinheitlichung* and *Sonderung*. ——

It is unfortunately inevitable that an ordered presentation of any psychological doctrine must, as things are, be couched in the language of some particular psychological system. The present writer is unable, on many fundamental points, to agree with Lipps. Hence it is but natural that the constructive part of the essay whose contents have been here outlined should seem to him less successful than its critical sections. It must, however, be said that a translation of the author's position into other terms is easily possible. As criticism, the essay is very certainly deserving of high praise. Dr. Nadejde has attacked an obvious and important problem which has been neglected, or at least but very partially treated, by his contemporaries. He has thus done a real service to scientific psychology. Such problems are, of course, not to be solved out of hand, and there will, without doubt, be reply and counter-reply and reply again. But, at any rate, a shrewd blow has been struck at the teleological interpretation of the feelings.

E. DANBY.

Philosophie der Werte: Grundzuge einer Weltanschauung, von HUGO MÜNSTERBERG. Leipzig, J. A. Barth, 1908. pp. viii, 486.

It was in 1808, exactly a century ago, that Johann Gottlieb Fichte issued his "Reden an die deutsche Nation." The tremendous influence of this work is well known. As Professor Münsterberg puts it, Fichte's "Weltanschauung war ein künstliches Denkgebilde, aber wieder bewährte es sich, dass der Idealismus des abstrakten Denkers

im Grunde die lebendigste und wirkungsvollste Lebensmacht ist. Sein reiner Glaube an die ewigen Werte ergriff die tiefste Seele des Volkes." But Fichte's idealism presently sank into disrepute, overwhelmed by the positivism of natural science. There was only one world, the world of observed fact; and all the 'riddles of the universe' were set by that and must be answered, if they could be answered at all, in terms of science itself, of elements and laws of occurrence. Then came the inevitable reaction against positivism, and the steady trend towards epistemology and away from metaphysics, that are characteristic of current philosophical thinking. Facts in themselves become tiresome; the thinker turns "zur Erkenntnisfrage, zur Frage nach dem Wert der wissenschaftlichen Behauptung;" he begins to enquire "nach Sinn und Bedeutung." So the concept of *value* is brought to the forefront of philosophical interest. A mere "Umwertung der Werte" is, however, not enough: we must, says Professor Münsterberg, push our investigation to "das tiefste Wesen der Bewertung." "Die Gesammtheit der Werte muss grundsätzlich geprüft und aus einer Grundtat einheitlich abgeleitet werden." What our latter-day philosophy lacks is "ein in sich geschlossenes System der reinen Werte;" only when we have this "kann die Philosophie auch wieder aufs neue zur wirklichen Lebensmacht werden, wie es zu lange ausschliesslich die Naturwissenschaft gewesen ist." Its provision is by no means easy, but rather a matter of keen and laborious thinking; it will not suffice "die grossen Gedanken des deutschen Idealismus noch einmal auszusprechen." Natural science has intervened; more especially "die Naturwissenschaft vom Seelischen, die Psychologie, hat ganz neue Ausblicke eröffnet; neue Wertgebiete des praktischen Lebens haben sich aufgetan; wir sind andere Menschen geworden." The day for reconstruction may, perhaps, not yet have arrived; but its arrival may be hastened.

In this spirit, the author lays before the public his own Philosophy of Values, which falls into two parts, a brief introductory theory of values and a system of values. The book is designed to turn our attention from laws to ideals, from the pleasurable and the useful to the sphere of pure duty, from material things to free will, from the world of facts to the world of eternal values. That it is a notable attempt goes without saying; it is the expression of a strongly marked personality, and shows a sustained fervor of conviction. Nevertheless, it is, in the fullest sense of the phrase, a "künstliches Denkgebilde;" and without running to the other extreme, of a raggedly pragmatic universe, we may surely say that the age of such systems is past. Individuals, men of like temperament with the author, will find in his pages inspiration and encouragement. All readers of the book will derive from it the benefit of a moral tonic. The circle of Professor Münsterberg's admirers will be increased. But that the doctrines which he sets forth will appeal, vitally and enduringly, to any large body of academic youth, whether in Germany or in the English-speaking world, seems hardly possible. The next reformation in thought must come from within the sciences, not from the external realm of concepts. M. W. WISEMAN.

The Philosophy of Loyalty, by JOSIAH ROYCE. The Macmillan Co., New York, 1908. pp. xiii+409.

These lectures were first delivered in their present form before the Lowell Institute in the autumn of 1907, although their substance had been given in various places at other times. "It is simply an appeal to any reader who may be fond of ideals and who may also be willing to review his own ideals in a somewhat new light and in a philo-

sophical spirit," and its aim is to simplify the moral issues of the day, in which there is restlessness regarding the foundations of morality.

Loyalty is defined as "the willing and practical and thoroughgoing devotion of a person to a cause." It is never merely emotional, it involves self-control, and it has a social cause. It has value for the individual, because it frees him from doubts and unifies his life. By nature we have no personal will; we find our will in part by imitation, social conformity, and when this proves insufficient, we swing back to caprice, finding satisfaction in neither, until we weld both factors in loyalty to a cause, "So rich, so well knit and to him so fascinating and withal so kindly in its appeal to his natural self-will that he says to his cause, 'Thy will is mine and mine is thine. In thee I do not lose but find myself, living intensely in proportion as I live for thee.'"

The philosophy of loyalty agrees with individualism in recognizing that no impersonal theory can be successful, that each person is the centre of his own world and must have his own end. But it points out that the ends set by mere individualism do not solve the individual's problems. Mere self-assertion in any form, thinks Prof. Royce, is an empty and futile process, because there is no self until it is made concrete in social relations. On the other hand, mere subjection to social relations also destroys the self, so that our only way of realizing the self is to combine our individuality with society in the form of loyalty to a cause.

Such a cause must be one in which the person can realize himself fittingly, and this can happen only if it joins many persons into the unity of a single life. It must be both personal and super-personal. Loyalty to my cause must also help to sustain others in loyalty to theirs, and in so far as my cause prevents this, it is a bad cause. Loyalty to loyalty is the final end and standard in selecting our cause, for this is simply finding the harmony between self and the world in some practical work. Such a standard gives conscience a touchstone to decide doubtful cases by because it furnishes an ideal and thus virtually creates a self. In a conscientious person doubts arise when loyalties conflict with each other, and in such a case our principle of loyalty to loyalty says, "Choose that which is more loyal to loyalty. If you do not know which is the better cause, at least decide, even if you must do so ignorantly, and having chosen, abide by your choice with courage and loyalty. Even this is better than hesitancy."

Loyalty is the great need in America to-day, first to the family, and secondly to political institutions. The latter gives rise to an especially difficult problem because our country is so impersonal and big that it is hard for men to be loyal to it as of old. They are loyal, intensely so, to their class, but not to their country. We need a new provincialism, a loyalty to city, and to state, as a training for the wider loyalty to our country.

Training for loyalty begins in early childhood with the idealization of heroes; it is found to some degree in gangs, codes of honor and the like; at adolescence it crops out especially in fraternities and loyalty to one's own side or institution. These natural forms should be utilized and guided by wise leaders, towards an idealized cause which demands strain and sacrifice from its followers. Idealization of the cause is of all these the most important, as is seen in the fact that some of the "lost causes" have been those which have most influenced the world, such as the idealization and transformation of the Kingdom of Israel into the triumph of righteousness. Through the power of grief and imagination loyalty to such a cause is so heightened that the

man is stimulated to ever greater efforts and to a union of his cause with that of all loyal souls, with art and with religion.

Loyalty thus comes to appear as the service of a superpersonal cause, and involves a higher unity of consciousness than that of ordinary human individuality. That is, "the social will is a concrete entity, just as real as we are and of a still higher grade of reality than ourselves."

At this point Prof. Royce makes connection with his theory of the Absolute. The faith of the loyal has truth; a world of truth implies a world possessing a rational and spiritual unity, a conscious world of experience, whose type of consciousness is higher in its level than is the type of our human minds, but whose life is such that our life belongs as part to this living whole." He then proceeds to a criticism of Prof. James's statement of pragmatism.

James says, "'The true,' to put it very briefly, is only the expedient in our way of thinking, just as 'the right' is only the expedient in our way of behaving." "It pays for our ideas to be validated, verified. Our obligation to seek truth is part of our general obligation to do what pays. The payment true ideas bring is the sole why of our duty to follow them."

First of all Royce agrees that the search for truth is a practical activity with an ethical purpose, and that its attainment means a practical success in active undertakings. But what constitutes success? Surely not the success of the mere instant, not the expediency which views only to-day. James himself inserts the phrase "in the long run" to broaden his expediency and success. But when does a man experience all the facts about the long run? "To appeal to the genuinely real 'long run' is only to appeal in still another form to a certain ideally fair conspectus of my own whole life, a conspectus which I, in my private human experience never get." That is, the admission of the long run, means that we judge our success by some ideal,—which Royce seems to assume to be an Absolute—instead of by the instant.

That is, says Royce, upon the basis of our need for unity, we form ideas of what such a unity of experience is. If these ideas are true, "then such a unity does actually exist and is experienced in some conspectus of life which wins what we need, approves our loyalty, fulfills our rational will, and has in its wholeness what we seek. And then we ourselves with all our ideas and strivings are in and of this higher unity of life." This is an eternal truth. To deny this reality only reaffirms it in another form, saying that the whole truth is that there is no truth, and hence we derive the proof that truth and a real world actually exist.

Now this truth is simply the Eternal, conscious, united, self-possessed, and perfected through our devotion to it. Loyalty thus becomes "the will to believe in something eternal and to express that belief in the practical life of a human being," and success and concord with the truth come in so far as each person is in unity with this Eternal or world consciousness.

Prof. Royce's criticism that when Prof. James appeals to the long run he virtually appeals to an ideal conspectus, is indeed a valid one, and if the long run is carried out to its logical end, pragmatism must admit that the final practical testing of any act is never finished until the universe itself comes to an end. That is, pragmatism makes its appeal to faith as a principle of action, saying, "Be bold! Absolute truth is unattainable, and if man is to live at all, if he is to act at all, he can do so only by a prophecy of success and the effective faith in his prophecy that makes him act as if the prophecy were already a

fact." If the results are harmonious with the rest of his and other men's experiences, then *in so far* he has a guarantee of fact and truth, although theoretically the widening experience of mankind may put this particular act out of commission at some future time. The reviewer has not yet been able to see why any pragmatist may not have a completely worked out *theory* of an ideal world, perfection, and so on, which serves as his working hypothesis, but of which the *truth* is tested by every act, and which must be modified accordingly.

This, however, is far from saying that such an ideal or that any ideal is a *fact* outside of individual experiences or that there is an *actually existent* objective unity of experiences, of which each person's individual life is only a fragment. It is difficult to see upon what grounds Prof. Royce makes such an assumption. The person who denies such a reality does not need to affirm that the whole truth is that there is no truth. He may say that assertions about "the whole truth" can refer to facts only if they refer to the present totality of experiences—including, of course, all ideas and ideals, and that such "whole truth" develops with the development of life and mind. To assert that at each instant there must be somewhere a conscious unity of all experiences is surely an assumption which rests upon the pragmatic motive of the individual's need for it in order to unify his own thinking. As such it may be altogether justifiable, but it should be held as an assumption and not as a demonstrated fact.

Considering the book as a whole, it will doubtless appeal to a large class of readers who stand in just such need as the author mentions of some stimulus to deepen and make more serious their moral lives. There is a great deal of repetition, not only of phrases but even of paragraphs and almost of pages, but this may be of value in fixing the few fundamental ideas which the author is trying to enforce.

AMY E. TANNER.

Etudes d'Histoire et de Psychologie du Mysticisme, Les grands mystiques chrétiens par HENRI DELACROIX. Paris, F. Alcan, 1908. pp. 470.

For this psychological study M. Delacroix selects Saint Theresa as a representative of the Spanish mystics of the sixteenth century, Madame Guyon, of the French mystics of the seventeenth, and Suso, of the German mystics of the fourteenth. He selects these three especially because they have left letters and autobiographical writings freer from doctrinal taint and with more pure introspection than have some other and perhaps better known mystics.

The mystic is a person who believes that he apprehends immediately and internally the divine presence. His tendency is complementary to if not opposed to rationalism. It is usually based upon or in ascetism and self-renunciation in various forms, and is marked by passivity, a sense of the divine presence, and loss or enfeeblement of the feeling of self and its mental functions. In its most typical forms it passes through three stages: a stage of exaltation, of various degrees, from contemplation up to complete trance, which is only temporary and which holds the mystic passive; second, one of sorrow or pain, intensified by the contrast with the previous state and corresponding somewhat to the modern "conviction of sin;" and third, a permanent consciousness of divinity, which is not characterized by trance visions, or any of the other somewhat abnormal marks of the first state, and which heightens the mystic's bodily health and powers and makes him able to deal with all sorts of practical problems to a greater degree than before. The first stage is not uncommon, the author believes, and is found often in persons of marked hysterical tendencies. It is often brought on or heightened by fasting and bodily

mortification and is often marked by hallucinations of various sorts as well as by catalepsy and sometimes epileptic attacks. This first stage, with these phenomena, is, by the great mystics, looked upon only as preliminary and as untrustworthy in itself. They say that their visions cannot be trusted, except as they lead to greater efficiency, for visions may be from the devil as well as from God; which, to modern psychology, means that nervous tendencies with a vivid imagination may lead either to a poem, an invention or to crime. But in the third stage, in which the presence of God is constantly felt, the mystic cannot doubt the divine presence because he judges it by its works, its effects upon all his daily activity. He feels within himself a power directing every thought and movement, doing tasks beyond his previous powers, giving wider scope and force to his mind, depth to his affections, and energy to his will. It acts like an external force, and he never questions that it is external and divine.

Why does the mystic have such an experience? Various factors unite, in the opinion of M. Delacroix. At the basis of it lies an unusually rich subconscious self, and along with it, a tendency to lose the conscious self in intuition. These are essential for the internal experiences. In addition must be included the somewhat abnormal life led by the great mystics, usually celibate, with fasting, perhaps scourging, and other forms of bodily privation, in some instances with long attacks of illness, or distinct neurotic tendencies. All these make vision and trance easy, and alone would tend to the passive forms of mysticism so common among Orientals. But Christian mysticism in its highest forms advances to the third stage because these mystics have been brought up within the church and have in their subconscious selves a vast fund of Christian tradition towards a life of practical piety. They have usually been faithful children of the church, under the care of a director, or under the influence of church writings, and all the suggestions from these sources have reacted beneficially upon the natural tendencies, to an outcome in which we find a union of contemplation and action which in its value and perfection can best be compared with the highest forms of art. The mystic's life is his work of art, shaped as the artist shapes his statue.

In giving this psychological explanation of mysticism the author by no means intends to discredit it. He rather aims to give a new form of justification to the tendency, emphasizing throughout its beneficial effects upon the person. He studies in great detail the experiences of Saint Theresa, Madame Guyon and Suso, even to the point of over-much repetition when he comes to the summing up; and the history of the controversy between Madam Guyon and the church, with the quarrel of Bossuet and Fenelon, seems aside from the aim of the book. On the whole, however, the book is both an interesting and valuable addition to the psychology of religion.

AMY E. TANNER.

The Inward Light, H. FIELDING HALL. The Macmillan Co., N. Y., 1908. pp. 228.

This book is a presentation, largely through symbols and figures of speech, of the teachings of Buddha as found among the Burmese today. The writer says that western writers have failed to understand Buddhism: 1, Because they have assumed that the formal teachings of Buddha are the whole of Buddhism, whereas in addition there really is all the teaching that preceded him and which he only complemented; and 2, they assume that the fundamental conceptions of the universe are the same for the West as for the East, which is not so. Before we can understand what Buddha taught, we must, then, know the underlying conceptions of life of the East, and the social

system upon which he built his teachings. A Westerner fell sick in a Burmese village and was cared for by the monks there. As health came back, for the first time he saw the beauties of nature and the goodness of life, and he asked himself where his life had brought him so far. Whither do life and work lead? What is life? He began to ask the monks and the villagers. He found that they conceived of Life as one great whole, of which all lives are but different manifestations, and this great Life has a Consciousness, a Righteousness and a Knowledge. We call it God, but this word is mixed with ideas of personality and limitation quite foreign to Buddhist thought. The world is the living garment of this Life, and all the forms in it have evolved from lower forms, all obeying their laws, all happy, even in death. The soul, too, of man, has evolved, not bearing a conscious memory, but in its present height and development showing its past righteousness or sin, acquiring 'merit,' ever acquiring greater power, ever widening, until it reaches a perfection that makes it existent without the limitations of matter. Each personality is a beam of the eternal sun, and each is necessary to make the ray of pure white light,—the rays below the spectrum, which make up unconscious life, all those in the spectrum, and those above it—all are needed for the white ray. Love gives the immortality and power of the unconscious life, without which the Soul could not exist, and in so far it is divine. The immortality given by love widens into that of the community, and that into the nation, but always below the nation is the family, and if its truth is not kept, then will the nation die.

There came a famine and many died because, says the West, they were ignorant and thriftless. But the East answers, "you live ever in fear of famine. We would rather suffer famine than fear, for famine is only of to-day, but fear is a part of the soul." The East has ignored the body, in its submission to fate, but the West has ignored the soul in its desire for freedom, and has become the deeper fatalist of the two. All ills pass. Justice underlies all, in this life or another. Be therefore of good cheer. Laugh, for death is but the beginning of a new life. New things are ever ahead for him who follows the Way, and merges the lesser into the greater Life by self-renunciation and self-denial. He who follows this Way finds peace. Each must keep his own truth, that it be not forgotten, but each must also remember that others have their truths to keep, which, too, must not perish from off the earth. Men have their truth to keep, a truth more primitive and stern than women's; and women have their truth, which is best expressed in the truth of Buddhism and of Christianity, and which rests upon the truth of men as the pagoda spire rests upon its foundation.

God, then, is the pure white ray (not a personality, a limited God), but the greatest realization of the Infinite God. To it we cannot pray as to one who may be moved by prayer, but is this the root of prayer? Not so. Our need of prayer comes from our isolation, ignorance, lovelessness. We want the inward light that never dies, for only so can we never be cast aside and forgotten. This is what prayer does—brings our tiny ray of light into the infinite ray, completing us and it in a perfect fellowship. Hell, then, is but the present suffering our present sin entails, and Heaven the everlasting reward of growth to the struggling soul, the greater light, the becoming one with the Infinite Ray. That is Nirvana.

Throughout, the book is a very simple, beautiful, sympathetic presentation of a great religion. It brings out similarities between the Eastern and Western modes of thought that cannot but increase our consciousness of the fundamental unity of all religion.

AMY E. TANNER.

Geschichte der Autobiographie. Von G. MISCH. Bd. I, Das Altertum. Leipzig und Berlin, B. G. TEUBNER, 1907. pp. viii, 472.

In 1900 the Prussian Academy of Sciences made the History of Autobiography the subject of a prize essay. The present work—which is to be completed in three volumes—was submitted in competition for the prize. Whether the author was successful we are not told; had he been, we should probably have read 'preisgekrönt' on the title-page. However that may be, the book is interesting and important; and if there is to be another publication under the same title, we may assume that the two histories will no more duplicate each other than in the analogous case of Dessoir and Sommer.

This Vol. I treats of autobiography in the ancient world; in the Hellenic and Attic, and in the Hellenistic and Græco-Roman periods; and lastly in that typical age of self-examination which culminated with St. Augustine. Vol. II, which is to appear shortly, will bring us down to the seventeenth century, and Vol. III will complete the history to our own times.

In his introduction, the author points out the relations of autobiography to history, psychology and sociology. We have in it self-portraiture and self-criticism, clothed in the language of the 'inner experience;' we have in it a reflection of historical fact, of actual occurrence, as the varying and various interests of the writer lead him to record the objective experiences of himself and of his fellows; and we have in it a description of social and political relations, of the "Selbstbehauptung des politischen Willens," of the relation of the author to his work and to his public. The primary motive is that of self-portrayal, of *Selbstbesinnung*. This, however, may wear many different forms, appearing as reflection upon character and human relationships, upon the conduct of life, upon human destiny, upon religious conceptions. Only gradually does it take on its modern significance. "Der eigenste Kern der europäischen Selbstbesinnung ist die Gestaltung des Lebens aus dem Bewusstsein der Persönlichkeit. Dieses Bewusstsein gehört nicht zum gemeinsamen Besitz der Völker, im hellen Licht steigernder Kulturarbeit ist es allmählich erworben worden, es kennt die mannigfaltigsten Weisen und Stufen, und auch die anderen Richtungen, die Lebensweisheit und die Erhebung zum Ewigen, gewinnen erst durch die Verbindung mit dem Persönlichkeitsbewusstsein ihre diesseitige Vollendung—in solcher Selbstbesinnung wirkt die Autobiographie mit an der Befreiung und Vertiefung des Lebens." This developmental view of self-examination, which "den innersten, langhin erst gleichsam unterirdisch verlaufenden Zusammenhang der Selbstbiographieen herstellt," is the key-note of the work.

The author begins with the autobiographical narratives of the elder oriental nations, of the Egyptian and Babylonian-Assyrian epochs. If we are to measure productivity by number, the autobiographical work of this age hardly lags behind that of the next two thousand years, from the beginning of the classical period to the end of the Renaissance. But "in dieser Fülle ist eine unendliche Armut an Individuellem:" autobiography is in its collective, impersonal stage; the motive of self-examination is working underground; self-consciousness has not yet arisen. When we come to the Greek period, we are on more familiar ground, on the ground where the continuity of history begins. Here, however, "tritt zunächst ein merkwürdiges Missverhältnis hervor: in dieser griechischen Kultur, die den Menschen entdeckt und befreit hat und so viele Formen, ihn darzustellen, fand, hat die Autobiographie nur einen beschränkten Raum, sie erscheint als eine literarische Spezialität von sekundärer Art." The author

goes carefully and seriously to work to account for this anomaly, and shows that, in spite of all appearances, the thread of *Selbstbesinnung* is never broken. In the Hellenistic period ("es ist ein Ruhmestitel der Forschung unserer Tage, dass sie die weltgeschichtliche Bedeutung der hellenistischen Epoche zur Anerkennung brachte") autobiography comes to its rights: die autobiographische Gattung hat im Hellenismus zuerst ihre zusammengesetzte Gestalt gezeigt, und in diesem vielköpfigen Wesen erhielt Persönlichkeitsbilduug endlich das Uebergewicht. Dadurch häugtdie Autobiographie nunmehr engermit dem Prozess ihrer Zeit zusammen, mit deren Grösse und mit ihren Schranken." But the fourth and fifth centuries, which saw the decline and fall of the antique life, the life of the ancient world, were the Augustan age of autobiography. "Die Autobiographie gewinnt eine Form, mit der sie sich ebenbürtig zu den Gattungen der grossen Kunst gesellen kann." This, indeed, is the one artistic triumph of the time. "So dicht erfüllt mit Kultur die überreife Zeit war, sie hat doch aus dem bunten Leben keine eigenen Kunstformen zu gestalten vermocht, das Christentum . . . hat überhaut bei seiner Ausbreitung in der alten Welt nicht die Kraft bewiesen, neue Literaturgattungen zu erzeugen, und selbst Augustin hat es nicht vermocht, sein Tiefstes objektiv, losgelöst vom persönlichen Erleben voll herauszubringen. Nur die Selbstbiographie hat eine neue Blüte getriebeu."

Such, in outline, are the plan and teaching of this first volume. It need not be said that the author brings a world of interesting detail; the chapters on Cicero, on Seneca and Epictetus and Marcus Aurelius, on Gregory of Nazianzus, on St. Augustine, would be interesting in themselves and apart from their context; they are doubly interesting in the context and connection that the author gives them. A technical review of the book would be the task of specialists in many fields. As a whole, it strikes the reviewer as a solid and notable piece of work.

F. E. BARBOUR.

Psychology, General Introduction, by CHARLES HUBBARD JUDD, Ph. D. New York, Scribner's, 1907. pp. xii+389.
Laboratory Manual of Psychology, pp. x+127.
Laboratory Equipment for Psychological Experiments, pp. vii.+257.

In the words of the author, as expressed in the preface, "This book aims to develop a functional view of mental life. . . In the second place, I have aimed to adopt the genetic method of treatment. . . In the third place, I have aimed to give the physiological conditions of mental life a more conspicuous place than has been given by recent writers of general text-books on psychology. . . In the fourth place, I have aimed to make as clear as possible the significance of ideation as a unique and final stage of evolution."

This is an excellent programme though it contains little that is new, as, indeed, it should not. A text-book in any science should have for its main purpose a clear and systematic presentation of the known facts in the science. Novel theories and individual points of view belong in special treatises.

The subject is throughout the book approached from the logical instead of the psychological or pedagogical point of view. This is not always fortunate from the teaching standpoint.

After a general introduction, to which Chapter IV on the general analysis of consciousness belongs, the author begins with the evolution of the nervous system, and then passes in successive chapters to the human nervous system and to sensations. The traditional five senses are discussed and the end-organs are illustrated, but the kinesthetic and organic sensations are scarcely mentioned.

The psychological aspect of sensations is treated in Chapter VI. This chapter really deals with perception, but this is not at once evident. The author seems to assume that the student already knows what perception is. After some general remarks that are not altogether lucid, the student is immediately launched into space perception. This is not approached from the side most familiar to the student, from space perception as simultaneously contributed to by the various senses, but is approached from the analytical side. Tactual space, auditory space and visual space are taken up in succession. It is here that the weakness of the logical, as compared with the psychological, method comes out more strongly than anywhere else in the book. A class is at a loss to know what it is all about.

The heart, and really the natural starting point, of perception is next treated in a section entitled "Unity of Objects." This section stands out as relatively clear and to the point, but it does not adequately cover the subject. The section on 'Time,' which comes next, is disappointing in its vagueness. The author makes no attempt to show what the experiences are from which one gets the concepts of 'past,' 'present' and 'future,' but devotes all his space to a discussion of the scope and origin of 'the present.'

A teacher using the book with a class would do well to begin this chapter with the section on the unity of objects, supplementing it liberally, to develop space perception independently before taking up the sections on tactual, auditory and visual space, and to omit the section on time.

The term 'experience' is used throughout the book as synonymous with consciousness, and not in its usual sense of the interaction between consciousness and the outside world. Chapter VII, entitled 'Experience and Expression,' deals with the motor nature of consciousness and with feeling. At the beginning of the chapter it is implied that all movement, even that of the internal organs, always influences consciousness. The uniform connection of consciousness and activity is brought out by numerous illustrations and references to experiments.

Attitude is indiscriminately treated both as an incipient reaction, illustrated by the attitude of attention (p. 189), and as synonymous with feeling (p. 193). This is likely to cause confusion in the minds of the class unless it is previously pointed out by the teacher.

Feeling is described as referring to 'intimate personal states, rather than experiences in which reference can be made to external objects' (p. 193). All mental states having subjective reference are here included. Feeling cold, a sensation, is put into the same class as anger and love, emotions. The terms emotion and sentiment are given passing notice in a later chapter (p. 298), but it is implied that there is little ground for them in psychology. In fact, one has the feeling all through the book that the real emotions and the higher sentiments are explained away. They have no place in Judd's scheme.

The James-Lange theory of the emotions is rejected, but no evidence is submitted on the other side beside the mere statement that "it has been shown that muscular contractions accompanying a feeling take place in time after the consciousness of the feeling has been fully established" (p. 195). "Feeling in its relation to bodily activity always reflects the harmony or lack of harmony of active tendencies" (p. 196). Since the James-Lange theory has been rejected, it must be assumed that the harmony or lack of harmony is only the occasion for arousing feeling, but this seems not always to be strictly adhered to (pp. 200, 204).

No inherent qualitative difference in the feelings as such seems to

be recognized. Are not anger, love, sympathy, æsthetic feeling, etc., distinct characteristics given in the native equipment? One would think not, from much of Judd's discussion in this chapter, especially the discussion on the appreciation of art and harmony (pp. 203-211). Just what is the source of these appreciations is not made clear, but they are not taken to come from sensation. In the chapter on instincts, native endowment for these capacities seems to be granted. This makes the treatment appear chaotic, but the psychology of the feelings must remain vague and chaotic till more is known and accepted regarding the functions of the brain. It will no doubt be found that the capacities for the fundamental feeling qualities have definite localizations in the cortex.

Instinct and habit form the subject of the next chapter. Comparatively little space is given to the instincts and no attempt is made to enumerate them. This is not surprising, for psychologists are not agreed as to what the fundamental instincts are, but until these are known psychology, as a science, can make little progress. They comprise the foundation of the science. We now have little more than opinions as to what the fundamental qualities of mind are, what is instinctively given and what is derived, what are the native capacities and at what point organization due to education and training begins.

Memory and ideas form the basis of the next chapter. This is an unusual combination of subjects and is of doubtful success. On page 241 ideas are described as modified memory images, and number forms are injected (p. 242) as evidence of the subjective character of ideas. But on page 244 f. ideas are described as the product of selective attention or analysis and abstraction, and this without any previous discussion of the nature of selective attention. In fact, selective attention and its implications are treated nowhere in the book, and it is this that makes Judd's treatment of the ideational processes so mystical and vague. It is minus its cornerstone.

The principles of association are briefly discussed in connection with memory. Scarcely a page is given to this subject, which is so fundamental in all mental organization. Two principles are recognized, contiguity and similarity, and no attempt is made to reduce them to one.

In training the memory, natural retentiveness and method of memorizing are not distinguished (p. 234). This leaves one in doubt as to just what the author means when he says that memory can be improved, but he seems to imply that natural retentiveness can. No evidence on the point is submitted.

The chapter on language follows the chapter on memory and ideas, and precedes the one on imagination, conception and reasoning. Since oral language is conditioned by conception and the higher thought processes, its exposition should clearly follow the discussion of these topics. Oral language also presupposes an exposition of selective attention. The chapter, however, ranks above the average in the book. The development of language, both oral and written, its social implications, and the manner in which words convey meaning are brought out.

In the chapter on imagination and the formation of concepts we again have an unusual and arbitrary combination of subjects. Imagination is closely related to memory, and ideas in their usual meaning are closely related to concepts, but these subjects are not so joined by our author.

Imagination is described as the radical change of memory images in the process of recall (p. 275). Individual variations in imagery are treated in connection with memory (p. 232). The personifying tend-

ency of primitive people is treated as the result of imagination rather than the result of uncritical perceptive inference, as it is now being regarded by anthropologists and historians. Imagination no doubt enters here after the process is started, but its beginning rests on a naïve assumption in which imagination has little or no place.

The function of the imagination in science is next set forth. Where empirical tests are inapplicable to imagined theories, their test is said to be "coherency of internal organization" (p. 277). Whether the author means here a mere internal congruity of parts, or that the theory must square with all known facts is not clear, but he seems to mean the former. This is indicated by the way he accounts for the postulation of the ether. "It is demanded in scientific considerations in order to make the idea of the solar system and the universe a coherent thinkable idea" (p. 278). Astronomers and physicists always convey the idea that the postulation of the ether is demanded by the undulatory theory of light,—something must undulate.

The development of a scientific concept is illustrated by the growth of the atomic theory and by the theory of gravitation (pp. 282-4). Such a concept he seems to identify with a scientific theory. It is defined as a scientific construct. Used in this sense, conception is not easily distinguished from imagination, and the distinction the author draws is a relative one only. "The image factor has become too attenuated, and the relational factor too important, to justify giving the construct a name which emphasized the image (p. 285).

In the usual sense of a symbol standing for a general notion or carrying meaning, the term concept is also used (p. 287-8). This phase of the subject is treated at some length in the chapter on memory and ideas, p. 237 f., and again in the chapter on language, p. 266 f., but without applying the term concept or conception to it. Judgment and reasoning follow the treatment of concepts.

To the concept of the self an entire chapter is devoted. The chapter on the whole is probably the most abstract and obscure in the book, owing in part, no doubt, to the nature of the subject. A good point is made, one that is seldom made explicit by psychologists, when the author says that in addition to the attributes of other concepts, that of the self "is characterized, also, by a unique type of activity which we do not know to exist in any of the forms of reality about us, other than personalities like ourselves. This type of activity we describe when we use the word 'consciousness'" (p. 311). Much is made of the unity of the self and its relation to the conceived unity of the external world. The author seems to assume that every one thinks of the world as a unified whole and that this unity is read into it because of the unity of the self. This is doubtful. Many people are distinctly conscious of the time when they gain a unified conception of the world, not having had it before. It usually comes as the result of study and experience, but in some it comes so gradually that it seems always to have been there.[1]

The remaining three chapters,—XIII, Impulse and Voluntary Choice; XIV, Forms of Dissociation; and XV, Applications of Psychology,—are among the best in the book, but lack of space forbids a detailed examination of merits and demerits. The discussion of voluntary choice is left somewhat obscure because the author assumes that the reader is familiar with the free-will controversy, which the beginning student seldom is. The question at issue is nowhere clearly stated, which leaves the student at sea. This omission of a statement of the problem under discussion is a frequent fault of our author and accounts for

[1] *Cf.* W. C. Ruediger: The Period of Mental Reconstruction, *Am. Jour. of Psych.*, July, 1907.

much of the vagueness throughout the book. Pedagogically this is a serious fault and seriously hampers the usefulness of the book as a text.

The laboratory manual of psychology gives a good selection of typical experiments for a laboratory course, and is bound to prove useful, especially to beginning teachers of psychology. The apparatus to be used with these experiments and suggestions for setting it up and for carrying out the experiments are given in the volume on laboratory equipment.

W. C. RUEDIGER.

George Washington University.

The Psychology and Pedagogy of Reading, by EDMUND BURKE HUEY, A. M., Ph. D. The Macmillan Company, New York, 1908. pp. 469.

Dr. Huey's book is well written, largely devoid of technical expressions and particularly well adapted to the needs of the class of readers which it aims to reach.

The book is divided into four principal parts: (I) The psychology of reading (9 chapters). (II) The history of reading and of reading methods (4 chapters). (III) The pedagogy of reading (6 chapters). (IV) The hygiene of reading (2 chapters).

Chapter I, taking the form of an introduction, deals with the mysteries and problems of reading from its beginning in Babylonia, Egypt, and Crete, more than 7,000 years ago. Chapter II treats of the work of the eye in reading. The eye, as is well known, does not move continuously in reading but by a succession of quick, short movements, with one usually unbroken return movement. As to the rate of movement, the results obtained by Dearborn, who used Dodge's method of photographic registration, are accepted. Chapter III investigates the amount of reading matter perceived during a reading pause. This has been measured, with fairly congruent results, by Erdmann and Dodge, Messmer, Cattell, Zeitler and others. It varies with the reading matter. There are limiting factors both on the side of eye structure and function, and on the psychic side. In consequence of the former, the larger the amount read during a reading pause, the more inevitably must be the reading by suggestion and inference from clews of various kinds. The deficient picture of the page is filled in and retouched by the mind; from which it follows that reading must go on by other means than the recognition of letters, and that the number of necessary movements and pauses per line will vary with the nature of the matter read. On the psychic side we are confronted by the narrowness of the attention span and by a third limiting factor, the necessity of interpretation.

The fourth chapter bears the caption "Experimental Studies upon Visual Perception in Reading." Herein are considered the mental processes concerned in perceiving what is presented on the page, and the means by which the mind takes note at such a rapid rate of what is there. The theory of reading by letters is obsolete. Already early experiments by Cattell had led to the conclusion that we read in word-wholes, or sometimes even phrase and sentence wholes. The results of experiments by Erdmann and Dodge argue strongly for the theory of the perception of word-wholes. As these authors point out it is not the constituent parts of any given form that make it recognizable, but the familiar total arrangement. While, of course, it is always possible to analyze the whole into its parts, we do not do this in actual reading any more than in regarding a landscape. Goldscheider and Müller ascertained that there are so-called determining and indifferent letters in words. With increase of familiarity fewer and fewer clews suffice to touch off recognition of a word or phrase. Zeitler's experiments led to the conclusion that the apperception of domina-

ting parts or complexes is the basis of recognition. Word length or total form are minor factors. We arrange, in fast reading, the dominating complexes one after another. The progress may be as rapid as one pleases, but it is none the less successive, though long practice and familiarity with the words may give one the 'illusion' of reading simultaneously what is seen during a reading pause. Messmer's experiments on the whole confirmed these facts. The greater importance of the first half and the upper part of words are additional results of experiment. Chapter V contains a discussion of the nature of the perceptual process of reading. It is difficult to draw final conclusion in the present state of science. All we can do is to survey the collected data and dwell on certain general features.

Chapter VI deals with inner speech during reading and with the characteristics of speech. Though purely visual reading is quite possible theoretically, auditory or motor processes form with most people a constituent part. Language and reading being so intimately connected that we can say with Egger that "to read is, in effect, to translate writing into speech," an examination of the nature of speech generally is resorted to in order to throw some light on the inner speech of reading and its relation to the interpretative processes. This examination, which draws freely on Preyer, Wundt, Joubert, Egger, James and Scripture, brings forth the followiug important facts: Language begins with the sentence, sometimes but a single word, yet standing for a total idea. We begin with a total meaning and a total intention of expressing this meaning, the development being toward a more and more particular division of it into aspects or parts. Meaning leads, and the idea of the whole dominates the parts. The total idea is not a mere sum of associations, but is an apperceptive unity. Again, if meaning welds the parts of a sentence into unity, the necessities of physical utterance contribute to the same end. The complex machinery required for vocal utterance is in continuous action throughout the utterance of any word or phrase, with no interruptions such as letters, syllables, or even words suggest. Chapter VII discusses the functioning of inner speech in the perception of what is read. The inner readiness for a new combination of words completes itself so readily from a few visual clews that it is unitarily perceived quite as truly as if it existed as a specific memory-whole. But the habits of inter-association and expectancy which bind the units of language into wholes are most deeply founded in the audito-motor mechanism of speech. Even in silent thinking the organization of our speech habits goes on perfecting itself. The carrying range or span of the inner speech being considerably larger than that of vision, the visual range is itself enlarged and its content supported by the more stably organized inner utterance into which the visual percepts are constantly being translated. The reading matter follows closely the associative habits of the language, and the existence of such inter-association habits are, therefore, of prime importance in making possible a large range of inner speech in reading. Chapter VIII is entitled, "The Interpretation of what is Read, and the Nature of Meaning." On the whole, meanings are usually felt as belonging to the larger wholes. Words are felt as having a part in the total, but their function is mainly to help tide one over to a place where a new meaning is suggested or completed. Imagery is a part always secondary or auxilary to the suggestion and control of meanings. The consciousness of meaning itself belongs in the main to that group of mental states, the feelings, which seem unanalyzable, or at least have a large unanalyzable core or body. The fact is that meaning is part and parcel of word-sound and word utterance, that is, what we take for the latter

two is largely word-meaning. It is safe to say that meanings in reading are mainly feeling reactions and motor attitudes attaching most intimately to, or fused with, the inner utterance of the words, and especially of the sentences, that are read. Chapter IX treats of the rate of reading, and the factors which condition speed. While the difference in reading time from page to page is small with individual readers, each falling into a reading pace most natural to him, the rate of reading varies greatly with different individuals. Experiments by Huey and Dearborn show that there can usually be much improvement. The thing to do is to make an effort to get away from our usual plodding pace, to read persistently as fast as possible and with well concentrated attention.

Part II, embracing chapters X to XIII, discusses "The Beginnings of reading, in the interpretation of gestures and pictures," "The Evolution of an alphabet and of reading by alphabetic symbols," "The Evolution of the printed page," and "The History of reading methods and texts."

The pedagogy of reading is taken up in the next six chapters (Part III) which are given to the following topics: "Present-day methods and texts in elementary reading," "The Views of representative educators concerning early reading," "Learning to read at home," "Learning to read at school," "Reading as a discipline, and as training in the effective use of books," "What to read; the reading of adolescents."

In part IV, treating of the hygiene of reading, "Reading fatigue" and "Hygienic requirements in the printing of books and papers" are discussed.

In the concluding chapter Dr. Huey takes up the future of reading and printing, showing possibilities of improvement which have never been canvassed, and for the elimination of waste. What we need now is more of particular researches on specific problems to furnish us with yet more of fact and of suggestion. M. W. MEYERHARDT.

Das Pferd des Herrn von Osten (Der kluge Hans), ein Beitrag zur experimentellen Tier- und Menschen-Psychologie, von OSKAR PFUNGST. Leipzig, Johann Ambrosius Barth, 1907. pp. 193.

It is rare that an experimenter is able to make a notable contribution, in a single piece of work, to both human and animal psychology, but that Dr. Pfungst has done in the case of a baffling problem by acute observation and a systematic application of the experimental method. The situation was briefly this. In 1904 there appeared in Berlin a remarkable reckoning stallion, the property of a retired schoolmaster living in one of the meaner quarters of the city, and making no effort to profit by the exhibition of his property. The horse was able besides doing other wonderful things to indicate by taps of his hoof the answers to problems involving the usual rules of simple arithmetic, including fractions, and to do this not only in the presence of his master, but also when the latter was absent and the problems were proposed by others whom it was quite impossible to suspect of fraud or collusion. Public interest in the matter was considerable and different sections of the public passed characteristic judgments upon the case. One party declared the case nothing but a piece of clever trickery; another held it to be a definite demonstration, at last, that animals could reason; while a third saw in it something occult, perhaps a case of telepathic transference of the results of the calculations from the mind of the master to that of the horse. The old schoolmaster himself declared that he had simply taught the horse arithmetic by regular pedagogical methods and that the horse had learned as children learn. Public interest ran so high that an in-

formal committee, composed of a number of distinguished scientific and practical men, made an investigation and published a report. In this they completely exonerated the schoolmaster of prompting the horse by intentional signals, and stated the opinion that unintentional signals of known sorts were absent. From this last statement the public promptly inferred that the committee meant to say that the horse did his own thinking, disregarding the remaining possibility that his behavior was regulated by unintentional signs of a sort as yet unknown.

At this point a systematic experimental attack upon the problem was begun by Professor Stumpf and his pupils which presently led to Dr. Pfungst's discovery of the set of minimal unconscious movements of the body and head by which the horse was set to tapping and again stopped at the number required. Once discovered, Dr Pfungst was able not only to execute these movements voluntarily (like the others who were able to get replies from the horse he had been executing them long unconsciously before he discovered them) and so lead the horse to any reply to any question, but he was able also to guide others to the observation of them in all those who succeeded in getting replies from the horse, and finally to demonstrate on a number of subjects in the laboratory similar and equally unconscious movements.

With this clue it was possible to explain in detail all the essential phenomena observed, even to the characteristic 'blunders' and 'mistakes' of the horse, and to give a natural explanation of how such a system of unconscious signalling by the master and of response by the horse could have grown up in the course of such "education" as the horse had received at the hands of Herr von Osten.

The explanation is doubtless absolutely correct and yet who would have ventured beforehand that differences in attention could explain so much — the delicate responsiveness of the horse to the movements of his master when his securing of bread and carrots depended upon it, and the obliviousness of the master to these same movements when his thoughts were otherwise engaged. The study is, all in all, a model in its field, and ought to be promptly translated into English.

For the details the text itself will, of course, be consulted. It includes, besides the six chapters of Dr. Pfungst, an introduction by Professor Stumpf, four appendices (on Herr von Osten's method of teaching, the report of the above mentioned committee, extracts from its protocol, and the final report made by Professor Stumpf in December, 1904) and a bibliography of 124 titles. E. C. S.

Are Bees Reflex Machines? An Experimental Contribution to the Natural History of the Honey Bee, by H. v. Buttell-Reepen, Ph. D. Translated by Mary H. Geisler. The A. I. Root Co., Medina, Ohio, 1907. pp. 48.

It is a pleasure to welcome, in an English version, this account of bee psychology by a German master of it. The work appeared first as a series of papers in the *Biologisches Centralblatt*, Vol. XX, 1900, as a counter blast to Bethe's stimulating but inadequate studies of ants and bees (Bethe: Dürfen wir Ameisen und Bienen psychische Qualitäten zuschreiben? Pflüger's Archiv, LXX, 1898), but is controversial only in presenting vividly the contrary facts. The work is full of interesting first hand observation with abundant references to literature and cannot fail, in its present form, to be useful to English students of bee behavior.

The difficulties and defects of psychological terminology are considerable at the best, but in comparative psychology they stand out in all their enormity. Hardly anywhere else would one meet in the same

paragraph a pair of sentences like the following: "On the basis of my observations I am of the opinion that bees possess either no cousciousness at all, or one of only the lowest degree of development." . . . "We see that bees show signs of an admirable memory in their orientation, and also in other activities; further, I believe I have shown that the bee possesses a perception for color and form, and develops a rich capacity for communication . . . that, further, it is able to gather experience, to learn, and to form associations of impressions, etc." It is perhaps fair to say that Dr. v. Buttell gives us warning elsewhere that he does not always mean as anthropomorphic as he says.

The printing of the work in this English edition leaves not a little to be desired. Lines five inches long in type as fine as that used in the body of the pages is none too easy to read, and when it becomes still finer type in the footnotes it offers positive difficulties. E. C. S.

Biology and Its Makers, by WILLIAM A. LOCY, Ph. D., Sc. D. Henry Holt & Co., New York, 1908. pp. 469.

In this work Professor Locy of Northwestern University has given to the educated public an untechnical but scholarly account of the rise and present status of biology and its problems. The book will be welcomed both for its contents and straightforward, thoughtful style by students, clergymen, teachers, medical men, and all interested in the achievements of modern science. At the same time the broad outlook over the whole biological field,—comparative anatomy, embryology, histology, etc.,—the comprehensiveness and continuity of the work, its clear statement of problems, its excellent table of contents, index, and bibliography up to date will commend it to the specialist. For those who know a little about biology and wish to know more Professor Locy's volume is positively fascinating. One finds the theory of organic evolution fully and adequately treated, to be sure, but in its right setting as part of the orderly development of a great science. The cell theory, the discovery of protoplasm, the rise of bacteriology, and of the science of fossil life, and recent controversies in reference to germinal continuity and the inheritance of acquired characteristics are all presented in their just relation. The generous amount of biographical material, the portraits and other illustrations, and Professor Locy's appreciation of and almost religious respect for the great leaders of scientific thought are sure to make his book of very great educational significance. This work emphasizes the zoölogical rather than the botanical side of biological science as indeed might be expected by all familiar with the research work of the author.

Northwestern University. W. LIBBY.

La Mano. Appunti antropometrici et antropologici, del Dott. E. AUDENINO. Rivista Sperimentale di Freniatria e Medicina legale delle Alienazione mentale, Settembre, 1907. Vol. 33, pp. 416-429.

The author of this article is an assistant of Professor Lombroso at the psychiatrical and neuropathological clinic at Turin, and summarizes a number of previous studies of the hand as well as giving the results of his own investigations. The palmar lines of various simians have been studied by Alix, Andreoli, Morselli, Carrara and others, and certain characteristic longitudinal, and in some species, transverse lines, have been made out. In man, these transverse lines tend normally to become more oblique, but both they and the longitudinal lines appear as atavistic phenomena. Dott. Audenio compared the frequency with which these lines appear in normal man, in cretins, insane patients and epileptics with the following results: In normal man about 21% of the hands examined (87 men and 13 women) showed more or less complete longitudinal lines, the frequency being greater

among women than among men; in cretins these lines were found in 66% of the cases examined (39 in number), usually crossed by transverse and oblique lines so as to form an intricate network, a disposition rarely found in the hands of the insane; in idiots (20) and insane patients (20) longitudinal lines were found in 45% and in born delinquents, moral irresponsibles and epileptics (44) in 52% of the cases. The most frequent longitudinal line is that extending to the base of the middle finger, that extending to the base of the third finger is less frequent, and that extending to the base of the little finger occurs most rarely.

The form and proportion of the different parts of the hand have also been studied and the following have come to be considered simian characteristics, a very short thumb, the middle finger much shorter than the length of the rest of the hand (as in many of the idiots studied by Morselli and Tamburini), the index of the hand in comparison with the stature higher than 11-12, *i. e.*, the height more than 11-12 times the length of the hand. On this point researches have been made by Hovelaque, Hervè, Quetelet, Pruner, Bey, Lombroso and Marro, both upon simians and among different human races. They found the following indices:

Gorilla,	14.5	Chinese,	12.8	Australians,	11.9
Chimpanzee,	18	Berbers,	11.1	Todas,	11.8
Orang,	20.8	Palmese,	10.4	White races,	10 (nearly)
		Javanese,	13	Arabs,	11.1
		Hottentots;	11.8	Japanese,	12.8

In epileptics Féré found an average index of from 11.5-11.7; in normal individuals Marro found it to be 10.6 and in delinquents 10.1-12.9. In regard to the greater length of the second finger as compared with the third there has been much discussion, but without arriving at any definite conclusions.

The author examined the index in all of his subjects, normals, cretins, idiots, insane, epileptics and born delinquents, but found no great difference in the percentages of the various forms, save that a low index was frequent in cretins. The length of the thumb was also investigated, but without marked results, except that the very short thumb occurred with greater frequency in cretins, and the very long thumb among idiots and imbeciles. Other proportions of the fingers were also studied, but without obtaining definite results. The article is illustrated and the illustrations show excellently various simian and human types, making available in very compact form the results of much research. THEODATE L. SMITH.

Rivista Italiana di Neuropatologia, Psichiatria ed Elettroterapia. diretta da G. d' Abundo, Professore Ordinario di Clinica delle malattie Nervose e Mentali nella R. Università di Catania, Vol. I, Fasc. 5, Maggio, 1908. pp. 48.

This new periodical, published monthly, is, as its name indicates, devoted to neuropathology, psychiatry and electrotherapy. The present number contains an article by Prof. F. Del Greco, Director of the Insane Asylum at Como, on "Incomplete Recoveries from Insanity," and calls attention to a class of patients who, having recovered a sufficient degree of stability and normality to be discharged from the asylum, are, nevertheless, not fully competent to cope with the complexities of the ordinary conditions of life, especially in cases where the struggle for existence is likely to press heavily upon them. Such patients, though apparently normal or nearly so under sheltering conditions, may, under an unfavorable environment, become dangerous to themselves and to others. Some of them seem to realize this and do not

wish to be discharged from the asylum. Dr. Del Greco makes a plea for the establishment of special colonies, a system which has already proved successful in Germany and France, where patients of this class may be under supervision, but not subject to the restraints of an institution.

The second article is a clinical report of a case of Jacksonian epilepsy with a detailed account of the findings of the autopsy.

Considerable space is devoted to book reviews and the number closes with a report of the first Congress of the Italian Society of Neurology, held April 8th-12th, at Naples. A résumé is given of the following papers presented at the Congress: Aphasia, by Prof. G. Mingazzini; Physiology and Pathology of the Frontal Lobes, by Prof. Bianchi; and the Structure of Nerve Cells, by Prof. Fragnito. Announcements for the Congress of 1909, to be held at Genoa, are also given as follows: Prof. Catola will discuss Acute Myelitis from the clinico-experimental point of view; Prof. d'Abundo, the Physio-pathology of the Optic Thalamus; and Prof. Moreschi, Serum-diagnosis in Nervous Diseases.

THEODATE L. SMITH.

A Mind that Found Itself, an autobiography. By CLIFFORD WHITTINGHAM BEERS. Longmans, Green & Co., New York, 1908. pp. 363.

The author was a rather brillant graduate of Yale in the class of 1897, who, soon after leaving college and entering business had an attack of acute melancholia and threw himself from the fourth story window of his home, was taken to an asylum where after some three years he regained his equilibrium, was out for a few days and then alternated into a very exalted and maniacal state after which he very slowly recovered. His book is of very great value and interest from two points of view; first, because he has remembered with such detail the items of his delusions and can reproduce in a purely objective way his states of mind when insane and describes so vividly how gradually everything cleared up. This is its pyschological part. In this sense the book is only slightly like that describing the recovery of Guillaume Monod who remembered although he still accepted in later years a few of the insanities of his morbid period. The second end achieved by this book and perhaps the chief one intended by the author is a criticism of the present management of our insane asylums, chiefly, though not entirely, the private ones. The evil lies first of all with the assistants who are often ignorant, utterly untrained, passionate, vindicative and cruel, subjecting patients sometimes to endless humilations and outrage which they couspire not to see and to conceal from the physicians in charge. Sometimes physicians themselves indulge personal spites and dislikes and often, in asylums the heads of which have made great pretence of the "no restraint system", use it in some cases in its very worst form. To be strapped so tight that even the fingers cannot be moved and that every breath comes hard, so that the clothes cannot be pulled up at night and to be left to moan in pain for twelve hours for a series of days is an inhumanity that ought to be abolished. These things this author suffered and, as we may well believe him, to his detriment. If his book contributes to effect a reform in this respect alone, it will do great service.

Mental Pathology in its relation to Normal Psychology: A Course of Lectures delivered in the University of Leipzig. By G. STOERRING. Translated by T. Loveday. Swan Sonnenschein & Co., London, 1907. pp. x, 298.

Professor Stoerring's *Vorlesungen über Psychopathologie* first appeared in 1900, and were at once welcomed by students both of normal and of abnormal psychology. The book met a real need, and

certain portions of it—especially the discussion of psychological method in Lect. i.—have, by their frequency of quotation, become in a minor way almost classical.

The translator "found himself hampered by the lack of any English work on mental pathology" to which he might refer students of psychology "without embogging them in a morass of clinical details." He, therefore, undertook the present translation, in the conviction that Dr. Stoerring "offers the student a judicious selection of cases and, as a rule, exercises a cautiousness in interpretation that may serve as a wholesome corrective of the extravagances characteristic of much recent amateur work on abnormal mentality." In the reviewer's belief, this favorable opinion is justified. The work of translation has been well and conscientiously done, so that the volume may safely be recommended for class-work in colleges and universities.

P. E. WINTER.

Insanity and Allied Neuroses. By G. H. SAVAGE and E. GOODALL. With 6 colored plates and 45 illustrations in the text. New and enlarged edition. W. T. Keener & Co., Chicago, 1907. pp. xiv, 624.

This little work, a member of a series of Clinical Manuals for Practitioners and Students of Medicine, was first published in 1884; republished in revised form in 1890; and, after several reprintings, has now been issued in a third, revised and enlarged edition. It is a practical and clinical manual, based on the authors' experience in the Bethlem Royal Hospital and the Joint Counties Asylum, Carmarthen, and is directly addressed to the medical student. Special attention has been given, in the present edition, to the sections which deal with pathology; and the six colored plates, showing the gross and fine appearance of the brain in certain pathological conditions, appear for the first time. The concluding chapters, dealing with the legal relationships of the insane and with the provisions of the lunacy act of Great Britain, will be of interest for comparative purposes to the American reader.

P. E. WINTER.

Hypnotic Therapeutics, by JOHN DUNCAN QUACKENBOS. Harper & Bros., New York, 1908. pp. 340.

Seven years have passed since the appearance of the author's "Hypnotism in mental and moral culture" and he now records the results of his experience which has been an unusually rich one during these years. He believes that by hypnotism and suggestion he can cause sleep, restore for a time at least those near death, that he can often cure pronounced cases of neurasthenia, delusions, obsessions, morbid fears and propensities such as kleptomania, mania for lying, imposture, and can even correct moral perversion, cure love when it reaches the intensity of mad infatuation and correct erotomania, dipsomania, absinthism, tea and coffee inebriety, addiction to cigarettes, cocainism and stammering, and that he can cause singers and actors who are paralyzed by timidity to overcome their diffidence and succeed on the stage. Suggestion to him is a means of perfecting the pulpit orator, teacher, business man and typewriter. Even literary inspiration can be helped, and "psychics" has its place in pedagogy and in the home.

Religion and Medicine, by ELWOOD WORCESTER, SAMUEL MCCOMB and ISADOR H. CORIAT. Moffat, Yard & Co., New York, 1908. pp. 427.

Of this book, with its twenty chapters, Dr. Worcester writes seven, Dr. McComb five, and Dr. Coriat six, with two jointly by the first two authors. The work, as a whole, represents what has come to be

known as "The Emmanuel Church Movement," which began nearly three years ago. Dr. Coriat's chapters, save the last, have little, if indeed any, relation to this special work, and are extremely elementary. The other writers believe that the church is now likely to enter upon a new epoch, in which the healing ministry of Jesus, which has almost been forgotten, is to be revived in a practical way; and this is a movement, which in its practical importance they think comparable to the development of the higher criticism on the theoretic side. For the psychologist who is at all familiar with border-line phenomena there is little new. The authors, for obvious reasons, cannot describe in great detail the cases that come to them. They take the wise precaution of having all the important cases first diagnosed by a physician, and thereby avoid treating those due to serious organic lesions or to infection. The real significance of the movement, which we deem great, is thus not at all in its scientific character, for it has nothing essentially new to contribute to the psychologist, but in the fact that it may mark a new departure in the church which will set a wholesome back-fire to Eddyism, which has swept into its ranks so many intelligent men, and especially women, who ought to have been safeguarded against the wilder extravagances of this strange phenomenon of our day. We are glad to know that similar movements have been taken up by churches of other denominations. We cannot forbear to add that it would be an even more wholesome tendency if something of this topic were taught in every theological seminary, for it is a significant fact that the only profession devoted to saving souls, generally teaches clergymen in its seminaries nothing whatever of psychology, which seeks to tell what the soul is and does.

The Physical Phenomena of Spiritualism, by HEREWARD CARRINGTON. Small, Maynard & Co., Boston, 1908. 426 p.

This book is a godsend to all those interested in spiritualism. Three hundred and twenty pages are devoted to fraudulent manifestations, and only about one hundred to what the author deems genuine residua. Under the latter he classes raps, telekinesis, the mediumship of Home, levitation, elongation, fire tests, and the trance states of Mrs. Piper. These latter the author admits that he takes from literature, and it is a little difficult to understand why he claims to be a spiritualist. His explanations of the ordinary tricks such as table-tipping, lifting, rope tests, paraffin moulds, sealed letter reading, spirit photography, spirit posts, sacks, handcuffs, and, best of all, his explanation of single and double, prepared and unprepared slate methods, are admirable; so is his section on the psychology of deception and on test seances. It is obvious that any one who investigates these phenomena will at once discredit most so-called spiritual phenomena. To our thinking, the author needs only to investigate a little more than he has done the tricks that the mind plays on itself, in order to understand that all those phenomena which he accepts are to be explained in the same way.

Behind the scenes with the mediums, by DAVID P. ABBOTT. The Open Court Publishing Company, Chicago, 1907. pp. 328.

The author gives here a very interesting account of his attempts to test spirit mediums with reference, for instance, to Bishop's concealed letter reading, trick envelopes, a letter filched from the pocket, a rapping hand, the oracle of the swinging pendulum, the use of telepathy, the spirit message on a slate, flower materialization, spirit voices, taps, lights, luminous costumes, various modes by which mediums read concealed letters, the different kinds of manipulation, etc. This will suffice to indicate the content of the book. It is a valuable unmasking and should be in the hands of every one interested in the subject.

Abriss der Psychologie, by HERMANN EBBINGHAUS. Veit & Co., Leipzig, 1908. pp. 196.

This little outline, which ought really to be translated into English, begins with a brief history of psychology. Then follows in the first section short chapters on the relation of brain to soul, structure of the nervous system, reaction and parallelism, nature of the soul. The second division is on elementary phenomena of psychic life—sensations, concepts, feelings, instincts, will. Then the fundamental laws of psychic processes—attention, memory, fatigue. Third, the outer effects of these processes seen in sensation and movement, concept and movement. The third division is entitled "The Complications of Psychic Life." Under the caption of the life of concepts, the author treats perception, illusions, memory, abstraction, with twenty good pages on language; then follows a discourse on the relations between that and knowledge and faith. The second part of the third section deals with feeling and action. Here first are discussed the causes of the complications of feelings—their intensity, form, association, irradiation, the passions and moods, and complex and free activities. The last section is devoted to the highest activities of the soul—the disadvantages or the evils of foresight, religion, art and morals. We only wish the book had been more copiously illustrated than with the very slight seven cuts.

Goethe's Wetzlarer Verwandschaft, von R. SOMMER. Leipzig, J. A. Barth, 1908. pp. 47. Mit 8 Abbildungen.

The argument of this little book is as follows. Goethe tells us that he had from his mother "die Frohnatur und Lust zu fabulieren." Since Goethe closely resembles in feature and expression his mother's mother, the question arises whether the "Lust zu fabulieren" did not come from his maternal grandmother. Of her, the Frau Stadtschultheiss Textor geb. Lindheimer, we have no record save a scandalous and untrustworthy statement of Senckenberg's. Of her father, Goethe's maternal great-grandfather, we know more: he was part author of a satire, "Diarium obsidionis Wetzlariensis," 1702,—though how much he wrote of this satire is unknown: the chief author was apparently a Dr. von Pulian. The satire (it is printed by Dr. Sommer) shows five characteristics: clearness of visual imagery, fanciful embroidery of real events ('confabulation'), pleasure in the drastic and grotesque, an underlying serious appreciation of cultural conditions, and a rationalistically pedantic and lawyer-like style. As all these characteristics may be found in Goethe's writing, we may conclude that Goethe owed the "Lust zu fabulieren" to the Lindheimer stock.

The weak points in the argumentation are clear enough. We know nothing of the temperament of the maternal grandmother; the satire was composed by "einige Wetzlarische Witzlinge" of whom Cornelius Lindheimer was seemingly not the chief, so that his part in its composition may have been small; the main characters of the satire, which is by no means underestimated by Dr. Sommer, are the characters of satire at large; and von Pulian was a lawyer, so that the 'Witzlinge' would naturally belong to his circle, and the legal style is accounted for. One would say that the positive evidence must be strengthened, and that there must be negative evidence (marked absence of certain attributes in the other lines of descent) to support it, before Dr. Sommer's conclusion can be accepted. P. E. WINTER.

The Riddle of the Personality, by H. ADDINGTON BRUCE. Moffat, Yard & Company, New York, 1908. pp. 247.

Much of this work originally appeared in Appleton's Magazine and

this sufficiently indicates its somewhat popular character. The writer discusses the subliminal self, the relations of the subconscious to American explorers, pioneers in France and the New World, the evidence for survival, the nemesis of spiritism, D. D. Home and Usapia Palideno, a census of hallucinations, hypnotism and the drink habit, hypnoidization, spiritism and telepathy, and the work concludes with hints for further reading. The author states that he has received "personal counsel and aid from Professor James of Harvard and from Professor Hyslop of the American Institute for Psychic Research and from others." The author thinks that such studies provide a corrective for the conclusions toward which the investigations of the psychopathologists tend, despite the fact that they have done much to alleviate human suffering. It is sufficient characterization of the work to say that the author is in quest of proof of a future life and thinks he finds it from these studies.

Plato's Psychology in its Bearings on the Development of Will, by MARY HAY WOOD. Harry Frowde, New York, 1907. pp. 62.

This master's thesis is really a valuable addition to the apparatus of the student of Plato. The author gathers his general views about mental activities, whole and part concerning appetite, emotion, thought, reason, will, and brings the various important passages together under each of these heads, showing excellent knowledge of the author in the original.

Modern Classical Philosophers. Compiled by Benjamin Rand. Houghton, Mifflin & Company, Boston, 1908. pp. 740.

This book presents in a series of extracts some of the essential things of the chief philosophic systems from Bruno to Herbert Spencer both inclusive. It is a history of modern philosophy based upon selections from the original text which are translated from the original into English. The author has sought to apply the case system used in teaching law. The work seeks to enable the reader to discover at once the content and method of the great and philosophic masters of modern times. The writers included are Bacon, Hobbs, Descartes, Spinoza, Liebnitz, Locke, Burke, Hume, Condillac, Kant, Fichte, Hegel, Schopenhauer, Comte, John Stuart Mill.

Lucretius, Epicurean and Poet, by JOHN MASSON. John Murray, London, 1907. pp. 453.

This book is really a Godsend to all teachers of the history of philosophy. It is comprehensive and learned and treats of the times of Lucretius; his life, his influence on his own age; the origin of the atomic theory; the atom of Lucretius; the birth of the world; how modern science bridges over the gulf between atoms and living things, the controversy as to the potency of matter; Epicurean psychology; atomic declination and free will; the theory of images; the Epicurean gods; the world as conceived by Lucretius; the roots of Epicureanism, Democritus; Epicurus as an ethical teacher; poetry and science; what the world owes to Lucretius; his teaching and personality.

The Will to Doubt: an essay in philosophy for the general thinker. By ALFRED H. LLOYD. Swan, Sonnenschein & Company, London, 1907. pp. 285. (Ethical Library.)

Truth, the author premises, has neither visible form nor body, is without habitation or name, like the Son of Man it hath not where to lay its head. This work is designed to be in some sense an introduction to philosophy, although it is really addressed quite as much to the general reader. The author seeks to meet a real emergency of the

day, namely, the doubt that is now so much abroad and fraught with so much danger and the evil effects of which are so often charged up against universities. His thesis is that doubt is essential to real belief. Hence his first chapter is the confession of doubt and then follows an account of the difficulties in the ordinary view of things, especially that of science since its rise. Its limitations are thought to be objective, specialistic, agnostic, although there may possibly be value in these essential defects of experience. The writer discusses, too, the personal, the social, the vital and the formal in experience. Descartes is taken as an early modern doubter. The most elaborate chapter is a characterization of the doubter's world, which is reality without finality; while really there is perfect sympathy between the spiritual and the material and a genuine individuality culminating in immortality. The last theme is doubt and belief. There is no closer approximation to the very basis of duty than the principle: Whatever is is right; and this is the summing up of the whole matter.

Erotische Æsthetik, by ERNST SUBAK. Ernest Hoffman, Berlin, 1908. pp. 79.

To this curious mind, the psychic activities are the highest form of an æsthetic sex function. The pleasure of procreation is irriadiated into and diffused through all art and even science, and every form of knowledge which is penetrated by any degree of interest and appreciation. Love in ascribing worth to a person does so to conserve the lover's own ego. Æsthetic appreciation is a sex function of the brain. Music, fine arts, philosophy, categories of knowledge of the external world, are explained so simply and beautifully and easily that it really is a marvel that it was left to our late day and to this youthful writer to explain all the problems of the noetic world at once by his "erotic æsthetics."

L'Idéal Moderne: La Question Morale — la Question Sociale — la Question Religieuse, by PAUL GAULTIER. Hachette & Cie, Paris, 1908. pp. 355.

The writer divides his exposition of the subject into three parts: moral, social and religious. In the first, he shows its independence, describes the renaissance of the antique ideal and defends individualism. In treating social morality he lays down the laws of public and private charity and solidarity, for justice and injustice, for the social antinomy that arises between liberty and equality, and finds its solution in liberal socialism. He then discusses the relations between religion and morals, and between science and faith, with a history of the latter and of revelation; and to conclude, characterizes the religion of the modern spirit. He retains the point of view of what he calls integral spiritualism.

Morals: a treatise on the psycho-sociological basis of ethics, by G. L. DUPRAT. Translated by W. J. Greenstreet. The Walter Scott Publishing Company, London, 1903. pp. 382.

The writer first treats of the method, discussing under its caption ethics, metaphysics, religion, scientific morality and the modes of ethical research. In the second part, under the caption of the psychological ideal, he treats the moral will, liberty and morality, the moral tendencies, the moral individual, determinism and immoral actions. Under the social ideal, he treats of social evolution, rights, the state, the economic organization, the family, friendship and the collective sentiments; and under part four, the struggle against immorality, the ethical sanction and moral education. As a whole the work is somewhat abstract, but it breathes the spirit of Ribot, Paulhan, Janet, Ferri and others.

A Manual of Ethics, by JOHN S. MACKENZIE. 6th impression. W. B. Clive, London, 1907. pp. 472. (University Tutorial Series.)

This is a fourth edition with no very great changes or enlargements. It is a systematic and comprehensive work dealing with the scope of ethics, its relations to other sciences, its divisions, desire, will, motive, intention, character, conduct, moral judgment, ethical thought and theory, various standards, virtues, moral life and institutions, social unity, duties, moral pathology and progress.

Philosophia Militans, by FRIEDRICH PAULSEN. Reuther & Reichard, Berlin, 1908. 233 p.

The author here prints eight recent papers, the chief of which are: The newest heresy condemnations in the field of modern philosophy; Kant the philosopher of Protestantism; Catholocism and science; Modernism and the encyclical of Pius X; Fichte in war for the freedom of thought; Hæckel as a philosopher, his world riddle as a folk book; and The Discovery of man in the nineteenth century.

Psyche und Leben, von W. v. BECHTEREW. 2nd ed. J. F. Bergmann, Wiesbaden, 1908. pp. 209.

In this second edition the author amplifies his views, which may be summarized somewhat as follows: Energy is primarily an active state of imponderable small particles, and when these break up there is no trace of anything physical left. The psyche may be a result of the transformation of energy so that it is not radically different from substance itself, so the ideas matter, energy, and psyche admit of being conceived in a unitary manner. Thus energy is intermediate between the material and the psychic world and has nothing originally physical about it. In its essence the psyche, like life, is neither movement nor energy, but in only both potentially. It can be transformed into outer material or inner subjective objects. Thus the entire world is the expression of unitary energy which includes potentially the psychic. This gives us the basis of the new parallelism and makes the world again a real unity.

Wunscherfüllung und Symbolik im Marchen, by DR. FRANZ RIKLIN. Deuticke, Leipzig, 1908. pp. 96.

The soul tends to work over the world towards conformity with its wishes. This is especially the case when thought is not in the closest contact with external reality; for instance, in dreams and revery. Poets create in fantasy what life denies them. Gottfried Keller was not a favorite with women, yet developed the highest ideal types of them; so Johanna Spyri described one of the most perfect children when deprived of her nephew. And so in countless cases, the wish creates a fancied substitute for reality and the tendency to identify the imagined object with experience is based on the deep instinct toward wish fulfillment. There are wish dreams and deliria, by prisoners, of freedom. Insane delusions are sometimes only desires expressed naïvely without critical reductives. Dead relatives who are intensely mourned for may appear perhaps as angels or ghosts with messages of comfort, and thus nature seeks to heal psychic wounds. So in myths there are wishing caps, love potions, seven-league boots, strength shirts and gloves, giants are overcome by magic weapons, there are miracles, mirrors that reveal all one wishes to know, riches, table delicacies, magic tables, etc. What does not at first seem the direct fulfillment of wishes becomes so when interpreted symbolically. Riklin has little difficulty in finding in mythology abundant sex myths to be interpreted as the Freud school interpret unconscious

constellations of ideas or wit. Thinking in symbols is a psychosis, an earlier culture stage; we see it often in dementia præcox and in various types of insanity. Animals, colors, jesters, angelic and demonic beings constitute a language of their own. General psychic states tend to incorporate themselves into specific forms and images, and this is most common in the submerged strata of the soul that represent a past stage of this evolution. Thus fire, genitals, weapons, beasts, are prominent in these early types and forms of thought. Transformations of men to animals and *vice versa* are symbolic. In all there is some transference upward or downward as shown by the method of diagnostic associations. Everything has hidden meanings. Thus in all such phenomena, we are really studying the psychic processes of primitive men, our very remote human ancestors.

Das Recht über Sich Selbst, seine strafrechtsphilosophische Studie, von KURT HILLER. Carl Winter, Heidelberg, 1908. pp. 114.

This author has the courage to imply that man has a right to commit suicide, mutilate himself, and in general may, with greater justice than has hitherto been assumed, exercise control over his own life in those matters which do not affect directly the well-being of others. This claim, of course, he does not make absolute, but discusses the American and other forms of duel, the murder of those who desire to be killed, homo sexuality, bestiality, abortions, etc. The author subjects to a rather gruelling discussion the norms which the German penal code uses to define the right of the individual to dispose of himself as he sees fit. He admits his work is in the nature of an isolated speculation and is based on the rather vague conception of natural rights. He says we thus reach the conclusion that "all the arguments for the legal punishment of those slain by their own consent, incest, pediastry, bestiality, and abortions are insufficient, and their penalization is inconsequent." The right of the individual to autonomously dispose of his own personality is now more and more reduced. All admit that he must not harm others, but no one can justify the interference of the State where this does not occur. Where others are harmed very slightly, there ought to be modifications, and the penal norms should be reduced. He admits that this is radical.

BOOK NOTES.

Die Cerebrale Sekundärfunction, von OTTO GROSS. F. C. W. Vogel, Leipzig, 1902. pp. 69.

Every nervous element that is functionally excited tends to persist in this state after the first cause has ceased to act. In respect, however, to this after or secondary function, individuals differ very greatly. Mentality is largely built up upon the intensity and duration of these after effects. If these are reduced and the excitability of the primary function increased, there is danger, and this is seen in its most flagrant form in mania. Consciousness is largely the result of this secondary process, which gives us groups of concepts and themata which the mind works out. One trait of degenerative constitutions is that consciousness becomes superficial or narrow. If these changes of secondary function are acquired and too diffuse, acute psychoses result. When the disturbance is circumscribed, paranoia follows. Even eras and time periods differ in ways best described under the author's rubrics.

Die Melancholie: ein Zustandsbild des manisch-depressiven Irreseins, by GEORGES L. DREYFUS. Mit einen Vorwort von Hofrat Professor Dr. Emil Kraepelin. Review reprinted from the Journal of Philosophy, Psychology, and Scientific Methods, Vol IV, No. 25, Dec. 5, 1907, pp. 692-698.

F. L. Wells gives us an interesting review of this important book, from which it appears that the author has made a careful study of eighty-one cases and believes that his results undermine the decision of Kraepelin that melancholia is a disease entity. It is suggestive that the last named author accepts these results in his introduction. Dreyfus makes here the first extended application of the statistical method in this field. He has made the best use of a continuous diagnostic policy which has extended over many years. After treating the history of melancholia, he shows that as early as 1878, it began to be recorded as a disease of the involution period. He traces the evolution of Kraepelin's views through the different conditions of his work, one main point of which is stressing the diagnostic value of retardation. In general, the involution melancholias are losing their integrity in the larger maniac-depressive group. From the depression of this group, however, it is distinguished by the presence of anxiety and agitation, and especially by the absence of retardation which is a factor of great and growing importance.

L'aphasie de Broca, by FRANÇOIS MOUTIER. G. Steinheil, Paris, 1908. 2 vols.

In these ponderous tomes, the author has discussed the history of the aphasia of Broca and its cerebral localization. Under this head, he treats of the anatomical documents of Broca; the observations, favorable and classic, in support of, and those contrary to, his theory of localization; the supposed syndromes of transcortical motor-aphasia; the theory of localization on the left side; the distribution of sense about the Sylvian fissure; anatomical dissociation and localization, according to Pierre Marie; the lenticular zone and that of Wernicke; the new localization according to recent studies. In the

next part, he discusses clinically the nature and symptoms of aphasia, beginning with the classical conception of Broca; he then takes up anarthria, clinical descriptions and the intellectual defect of aphasic patients; errors in diagnosing between dementia and aphasia; criticisms made by the new clinical studies of Broca; symptoms and verbal images. In the appendix, pages 251-769, the author prints justificative monographs from 1861 down; and from page 375 on gives observations that he has made himself. The work terminates with a bibliography, a lexicon of terms and a table of authors.

Prognosis in Cases of Mental Disease Showing the Feeling of Unreality, by FREDERIC H. PACKARD. Rep. from American Journal of Insanity, Vol. 64, No. 2, Oct., 1907, pp. 263-269.

In the allopsychic field, such expressions as "Things do not look real," in the somatopsychic field, the feeling that hands are changed, organs gone, etc., in the autopsychic field, that "I am not I, am dead," that "This is not Mr. So and So," are the three forms of a failing sense of reality. Packard thinks that all these deliriums of negation are due to anxious melancholy, and that the feeling of unreality is not an essential symptom of involution melancholy. He holds that this fantastic symptom should not be given too much importance, and that both diagnosis and prognosis should be made on the basis of more fundamental symptoms.

Heredity, by J. ARTHUR THOMSON. J. P. Putnam's Sons, New York, 1908. pp. 605.

This book has been long awaited with interest and will be read with satisfaction. Its author is, perhaps, the most holophrastic of all the able disciples of Weismann who write English. In the first chapter he defines and illustrates heredity and inheritance; in the second, discusses the physical basis of inheritance; in the third, heredity and variation; in the fourth, common modes of inheritance; fifth, reversion and allied phenomena; sixth, telegony and other disputed questions; seventh, transmission of acquired characters; eighth, heredity and disease; ninth, statistical study of inheritance; tenth, experimental study of inheritance; eleventh, history of theories of heredity and inheritance; twelfth, heredity and development; thirteenth, heredity and sex; fourteenth, social aspects of biological results. There are forty-nine illustrations, the text is good, the matter well distributed, the bibliography copious, and the work is admirably calculated to take a leading place among the text-books on the subject.

Organische Zweckmässigkeit, Entwicklung und Vererbung vom Standpunkte der Physiologie, von DR. PAUL JENSEN. Gustav Fisher, Jena, 1907. pp. 251.

This is a portion of a larger forthcoming "Introduction to general physiology." It begins by a criticism of Darwin's theory of selection, of auto-genetic and allogenetic theories. The variability of our organism is next characterized, its different types are pointed out and their significance for phylogeny is shown and the causes of progressive variability are traced. Then follows a critique of the various idioblastic and chromosome and the bioblastic theories. The purposiveness of organisms is discussed and the difference between true and false teleology is pointed out. The hypotheses of Ranke, Driesch, Wundt, Cosmann are briefly described, The relations of the whole problem to the monistic theory are next taken up, and this is the basis of the author's development of his own scheme of both description and classification. This work is a valuable addition to the repertory of the student desiring to put himself abreast of modern theories upon this difficult subject.

Versuch einer Begründung der Deszendenztheorie, by KARL C. SCHNEIDER. Fischer, Jena, 1908. pp. 132.

The first stimulus in the lowest form of life takes us at once into the psychic sphere. Under the law of the conservation of the psyche, all that passes from parent to offspring is a mneme. The psyche is the chief biological function throughout the entire evolutionary history of life. The first human soul was an epochful and spontaneous generation, when an over-consciousness was born that can turn upon nature and overcome her. The "exonoetic" process of experience is the origin of man. Just so far as he has become man, his physical development has ceased.

The Application of Statistical Methods to the Problems of Psychophysics, by F. M. URBAN. The Psychological Clinic Press, Philadelphia, 1908. pp. 221. (Experimental Studies in Psychology and Pedagogy, edited by Lichtner Witmer.)

The first chapter is devoted to the descriptions of the experiments. Then follow chapters on the statistical numbers of relative frequency, the method of just perceptible differences, equality cases, the psychometric functions, and lastly a general inquiry concerning these latter.

Grundzüge des Physiologische Psychologien, von WILHELM WUNDT. Sechste, umgearbeitete Auflage, Erster Band, mit 181 Figuren im Text sowie Sach- und Namenregister; Leipzig, Verlag von Wilhelm Engelmann, 1908. pp. 725.

This initial volume of the sixth edition of Wundt's great work has not only been carefully revised but increased considerably in bulk. New sections have been added in the introduction and earlier chapters, and a most radical working over has been given to the ninth chapter, the last in this volume, which deals with the Intensity of Sensations. The purpose here has been to bring out more clearly the psychological aspects of the matters dealt with and to recast the discussion of the psychophysic methods. A more detailed notice of the changes in this chapter will be given in a later issue of the *Journal*. The volume is provided with special indexes of names and subjects by Wundt's assistant, Dr. Otto Klemm. E. C. S.

The Influence of Alcohol and other Drugs on Fatigue. The Croonian Lectures delivered at the Royal College of Physicians in 1906. By W. H. R. RIVERS. Edward Arnold, London, 1908. pp. 136.

The writer first gives a history of the current methods of studying muscular and mental fatigue and that of attention, tracing the effects of drugs, etc. Subsequent lectures are devoted one each to caffeine, the influence of alcohol upon mental fatigue, of the use of cocaine, strychnine, tobacco, etc., while in the appendix a typical fatigue curve is given and a new apparatus for the application of MacDougall's method of studying mental fatigue. Every student of psychology and education will be glad to have in this volume an interesting and comprehensive description of the best methods and results that have been brought out by the many modes of studying this subject during the last decade or two.